The Bartlett School of Graduate Studies
MSc Construction Economics and Management

NHS ProCure21: analysing networks of inter-firm relationships

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This report is submitted in partial fulfilment of the requirements for the degree of Master of Science in Built Environment from the University of London.

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University College London

September 2005

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Abstract

Companies involved in construction have often had problems with their projects, leading to disappointing outcomes for those involved in the production of the built environment.

Drivers for industry change have come in the form of seminal reports such as *Constructing the Team* (Sir Michael Latham, 1994) and *Rethinking Construction* (Sir John Egan, 1998). One common theme of these inquiries has been the need for greater collaborative working on construction projects and the enshrinement of modernising principles within the set-up of projects.

Public sector procurement not only has to cope with the engrained problems of the UK construction industry, but has also inherited a legacy of underinvestment in public infrastructure and services. Recently, new public sector procurement routes such as the NEC form of contract have been produced to address these problems. The NHS, a major client, has introduced the ProCure 21 framework in this spirit.

The report deals innovative public sector procurement by using Social Network Analysis of a single case study project to examine how effective and appropriate ProCure 21 is. Social Network Analysis is identified as suitably innovative analytical tool, with important conclusions for construction firms drawn from sociograms of the various inter-firm networks used and recommendations for further research made.

Key Words

Construction project coalitions; social network analysis (SNA); intra-coalition networks; NHS ProCure 21; governance mode design.

Acknowledgements

This research was supported financially by Balfour Beatty and made possible by The Moorfields Eye Hospital NHS Trust. The author wishes to express his most sincere thanks to those organisations, as well as a large number of project team members who gave of their time to participate in this research. I am particularly grateful to Stephen Pryke of the Bartlett School of Graduate Studies, University College London for his guidance and advice, and to his colleagues Graham Ive and Hedley Smyth for their initial comments on my ideas. I would also like to thank the following people for their support: Tony Ellender, Colin Eke, Chris Shore, Eamonn Taylor, Chris Tickel, Natalie Townend and Calvin Broadus.

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List of abbreviations

BEDI	Building Environment Design Industry
BMCI	Building Materials and Components Industry
CI	Construction Industry
CDM	Construction (Design and Management) Regulations 1994
DETR	Department of the Environment, Transport and the Regions
DoH	Department of Health
FBC	Full Business Case
GIFA	Gross Internal Floor Area
GMP	Guaranteed Maximum Price
LADs	Liquidated and Ascertained Damages
M4i	Movement for Innovation
OBC	Outline Business Case
P21	NHS ProCure21 Framework Agreement
PBE	Production of the Built Environment
PFI	Private Finance Initiative
PPP	Public-Private Partnership
PSCP	Principal Supply Chain Partner
PSCM	Principal Supply Chain Member
SCM	Supply Chain Management
UK	United Kingdom

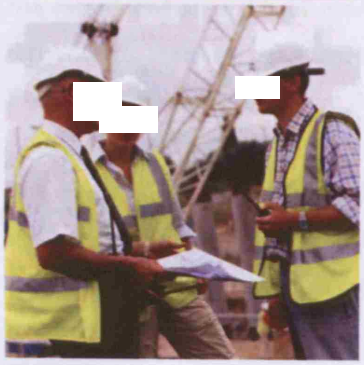
Glossary of terms

Actor — A discrete individual, corporate, or collective social unit. (Wasserman and Faust, 1997, cited by Pryke, 2004a).

Network Density — The ratio of the number of ties observed in a network to the number theoretically possible (Granovetter, 1976). Usually treated as a measure of group cohesion.

Relation — A collection of ties of a specific kind among members of a group (Wasserman and Faust, *ibid.*).

Social Network — A specific set of linkages among a defined set of persons, with the additional property that the characteristics of these linkages as a whole may be used to interpret the social behaviour of the persons involved (Mitchell, 1969, p.2, cited by Loosemore, 1998).



1.0 Introduction to the research

1.0 Introduction

This section provides a brief introduction to the research, outlining the value, content and objectives of the report.

The research problem is described in *Section 2.0, Statement of the problem.* The construction industry has introduced a wealth of new governance models and procurement routes in recent years in response to a set of persistent and serious industry failures. These new models, like the NHS ProCure 21 framework, require their own new analytical tools, such as *Social Network Analysis.*

The *conceptual framework*, described in *Section 3.0*, explains how the construction project coalition can be conceptualised in such a way as to enable the fruitful study of its relationships. Social Network Analysis and its application to construction projects is explained. The NHS ProCure 21 framework is described. The links between this report and the wider body of construction economics and management knowledge and debate are discussed.

Section 4.0, Enquiry and data collection provides a description of the project case study, a central London international children's hospital, and its participant firms. The procedures used in collecting and processing the primary data are also explained.

Section 5.0, Analysis and interpretation of the results, examines the output of the specialist Social Network software, sociograms of the various project networks. The position and connections of individual firms and groups of firms within networks are used to explain the role, influence and effectiveness of firms and the project as a whole. The *Conclusions* reached in *Section 6.0* provide an opportunity to draw out the main points of the analysis and consolidate a set of current beliefs about appropriate action relating to emergent and redundant roles, and project governance design.

Section 7.0 details a series of *Recommendations* variously made to construction practioners, policy makers and observers of the built environment. The sheer volume of useful data collected on a project using a innovative procurement route means that there is not scope to explore all its implications within this report, and that further study is recommended.

Section 8.0 contains the *Bibliography.* The *Appendices* in *Section 9.0* include the node lists (the 'raw' output of the computer analysis of the data) and copies of the questionnaire completed by those participating in the research. *Section 10.0* contains *Addenda,* where these apply.

This research, conducted under the *ægis* of The Bartlett School of Graduate Studies, University College London, may help us to better understand the dynamics of construction project teams and the value of NHS ProCure 21. To reach this point, economics and construction management theory must be melded with professional knowledge and the analytical tools of economics and management science adapted to fit a specific construction context.

2.0 Statement of the problem

2.0 Statement of the problem

Companies involved in construction have often had problems with their projects. New procurement routes, such as NHS ProCure 21, have been designed to address these problems. This report uses Social Network Analysis of a single case study project to examine how effective and appropriate ProCure 21 is.

This report examines a series of inter-firm social networks on a public sector project, with the aim of understanding the mode of governance at project level. It serves as a rigorous appraisal of ProCure 21 project networks, infused with both primary data and conclusions drawn from personal experience, both as a construction practitioner and a researcher of the built environment. The précis following sketches out the objectives of this report and how it's content addresses a set of significant challenges the UK construction industry currently faces.

When George Stephenson completed the construction of the railway from Liverpool to Manchester in the 1830 it had cost 45% more than budget and had been beset by several serious delays to programme (*The Economist*, June 11th 2005). Similar pressures are still being felt by today's construction managers, their companies and their project teams 175 years later.

The UK construction industry has begun a much-needed transformation in recent years, ostensibly one of modernisation and improvement. It follows that any understanding of the current construction industry should be pursued in full recognition of the value and appropriateness of new and original research techniques such as the *Social Network Analysis* used in this report.

The context

In order to understand data produced by the case study, we need to know the social relationships and institutional arrangements of the market. Thus it is important that we understand current specific construction industry conditions and their context.

Total world construction spending in 1998 was over $3 trillion (Crosthwaite, 2000), making it a major world industry. Unfortunately, the outcomes associated with construction have often disappointed those involved in it's production. This gap between expectations and the value realised on investments is a key strategic challenge, prompting calls for new ways of capturing and creating value in the built environment.

The construction industry is a large and important part of a large and important economic sector[i], with several distinct economic features (Ive and Gruneberg, 2000, p.149) including it's demand context (declining, fragmented, fluctuating and of a heterogeneous composition), separateness of roles and sequentiality of work.

The SSOCP [social system of organization of the construction process] exists to support and assist economic growth (Gruneberg and Ive, 2000, p.33) by creating the preconditions for successful capital accumulation, but it's characteristics simultaneously limit the size, rate and nature of CI growth, inherently limiting the ability of managerial efficiency or technical progress to increase productivity. Consequently, the industry is one of low margins, low future-orientated expenditure and low productivity.

The heterogeneity of demand, separateness of roles and sequentiality of work creates a demand for flexibility rather than productivity (Winch, 1996) and in avoiding capital lock-up; the CI has often avoided technical or managerial improvements (Ive and Gruneberg, 2000, p.182).

The UK construction market is one where prices are competitive, profits are average and outcomes disappointing. The fragmented nature of the UK construction industry induces intensive competition centred on price (Smyth and Thompson, 1999), with clients being encouraged to prefer cost leadership to differentiated services (Egan Report, 1998). The attendant adversarial relations and contracts destroy value, eliminate trust and promote a blame culture, characterised by contradictory modes of action,

> "Too little trust - and not enough money. A mighty machine which requires oil in it's engine to drive it has grit instead."
>
> (Latham, 1994)

In this view, the mighty machine of UK construction is stuck in one gear: reverse, echoing Bowley's (1966) description of the industry as 'backward'.

Contracting has become a homogenous organisational paradigm (Johnson and Scholes, 2002, p.503), with powerful symbols and stories reinforcing instutionalised behaviour and beliefs. The momentum of this *structuration* (Giddens, 1984, cited Winch, 2002, p.17) has produced a widespread inertia and resistance to change across the industry, much of which remains today.

The scenario of a familiar reward and penalty system (Pryke, 2003) for the actors has had a limiting effect upon management innovation within firms. Profits are typically too low (Egan Report, 1998)

and unreliable to sustain development, with crises of underinvestment in research and development and training.

The NHS ProCure 21 framework

Ongoing market transformations[ii] and the demographic, human resource, accountability and revenue pressures on the government and clients have been instrumental in the growth and proliferation of new management methods and procurement routes (Green, 2004).

This, coupled with political commitments[iii] has meant that successive UK governments have since been concerned to limit the level of public sector borrowing in the hope of minimising fiscal deficit, managing demand through tighter monetary policy and keeping inflationary pressures at bay. Unfortunately, this has created a legacy of underinvestment in public infrastructure and services.

At the level of the construction industry and it's clients, drivers for change have come in the form of seminal reports such as *Constructing the Team* (Sir Michael Latham, 1994), *Rethinking Construction* (Sir John Egan, 1998), National Audit Office reports and the Better Public Buildings Initiative. Key studies of procurement practice (such as Cox and Townsend, 1998 and Franks, 1998) have also shape the thinking of influential clients like the British Airports Authority.

Against this backdrop, the existing and limited NHS infrastructure has been increasingly unable to keep pace with the growth of the country and the rising demand for services and infrastructure from an ageing population (Jefferies *et al*, 2002).

The NHS ProCure21 framework (described in more detail in *Section 3, the conceptual framework*), in tandem with NHS LIFT [Local Improvement Finance Trust] and PFI/PPP, is part of recent efforts to meet this demand in a progressive and innovative way.

New governance modes, new analysis

The construction industry is currently in transition. Projects are rapidly increasing in value, in complexity and in the array of stakeholders within the client body, prompting innovations in procurement and project management approaches (Pryke, 2004a).

Theories about current project coalition models are often predicated about older, more traditional governance modes. Project coalitions have, in the past, often produced disappointing outcomes for

the firms involved. These outcomes may be partly attributable to an incomplete understanding and acknowledgement of the dynamics of construction project social networks.

This may help explain why innovative procurement is not consistently, in practice, producing effective teams. The dynamics of how goals, power, trust, incentives, benefits and dependencies actually manifest themselves may well be more accurately described and understood through Social Network theory, which acknowledges more realistic and detailed models of interfirm and interpersonal interaction.

The network perspective posits that economic behaviour and institutions are so embedded and constrained by ongoing social relations that to construe them as independent would be a serious misunderstanding (Granovetter, 1985); this approach is quite different from the rational, self-interested behaviour of economic mainstream thought. The determinants of supply and demand are not ahistorical (Allsop, 1995); firms in the UK construction industry operate within markets firmly embedded in their own distinctive political, economic, social, technological, environmental and legal contexts (Kay, 1993). It follows that the embedded nature of markets should be acknowledged in our analysis.

The production of the built environment can be characterised as a project-based setting in which many actors comprise a *Virtual Organisation*, the *temporary multiorganisational dynamics* (Cherns and Bryant, 1983) of which are central to project and cumulatively, corporate success.

The construction project itself might be described as a nexus of non-linear, complex, iterative and interactive processes; with highly compressed, concurrent and interdependent phases, all subject to a high degree of [known and unknown] uncertainties, with a prototypal end product as the objective (Pryke, 2004a).

Some of the new strains of project governance such as ProCure21 fall somewhere between the market and hierarchy models (Pryke, 2004a). They have been designed to promote and incentivise collaborative working and harness strong interfirm relationships.

Relationships and incentives

Contract and financial incentive arrangements are central to designing effective governance mechanisms. Non-contractual aspects are also important, and innovative procurement routes should guide teams to fostering productive inter-firm relationships based on communication (on items such as cost, progress, risk and design).

Relationships create new ideas, markets, methods and products; consequently, it is vital for the construction industry to make the most of the many complex webs of relationships that characterise construction projects. Although it is vital to acknowledge that sometimes the *zero relationships* of transaction marketing are the best strategy (Gummesson, 2002), transaction-specific investments and dependence are not always enough in that they both focus on present or existing conditions (Ganesan, 1994). The hazard of opportunistic behaviour implicit in such exchanges is reduced by strong relationships.

The term relationships, trust and commitment can sound like antiquated notions in comparison to some of the vocabulary used in analysis of the business environment. The truth is that these are essential mechanisms, developed to deal with social and commercial problems (in terms of contracts, operations and goodwill)(Kay, 1993, p.49), mechanisms not supplantable by aggressive or cynical individualism.

Game theory is used in the literature to motivate structured thinking about relationships. *The Prisoner's Dilemma* makes a powerful case for collaboration. The most successful long-run Prisoner's Dilemma strategy is to cooperate in repeated games, allowing defection from cooperation by the other party only once before resorting to defection, but never to defect first. (Winch, 2002, p.112) Long-term cooperation is the best strategy. Prisoners' dilemmas are not just abstract theory, they really happen; the "pre-emptive strikes" of George W. Bush illustrating a classical co-operate/defect dilemma[iv].

The creation of good relationships and open communication with the supply chain members will prompt greater co-ordination of their services and products with a contractor's strategic and operational needs. Increased collaboration, efficiency, response time and innovation from supply chain partners adds value to the project as delivered to the Client. Transaction costs and in initial capital costs are lowered in these exchanges, and an improved relationship may lead to the lowering of production costs as greater discounts are offered to the trustworthy main contractor.

Rather than inducing collusion or entrenchment, the effective alignment of buyers and sellers within the UK construction market is central to it's competitiveness; the market itself puts limits on and provides models of how firms should relate to each other.

Incentives are the cornerstone of the modern construction industry. (Levitt and Dubner, 2004, p.13) They aren't, generally speaking, organically generated, rather it is those who write new contracts, such as ProCure21, who devise them.

Incentives play a central role in project and cumulatively, corporate success. The problems of incentive incompatibility and asymmetry of information between buyers and sellers in these embedded markets can be addressed through the alignment of incentives. Alignment mechanisms create the preconditions whereby project coalitions are sustained by a blend of trust and money.

If a client restructures a contractor's incentives and the contractor mirrors this approach in it's supply chain arrangements, then an alignment of goals occurs; creating conditions in which positive spontaneous order and behaviour based on the common objective of client satisfaction can thrive (Kay, 2003). These internal mechanisms are the province of the project coalition; the potential benefits are the client's and the stakeholder's. Internally, alignment techniques may help bridge the gap between the interests of shareholders, managers and staff, addressing principal-agent and moral hazard issues (Winch, 2002).

Yet purely financial incentives used by firms (at the level of the individual) have not always proven to be clear motivators, and even when this is the case, the effects have often been only short-term. Firms still use financial incentives, as they are easy to set up and easy to change; but performance incentives in modern procurement have become more sophisticated, as the move from LADs [Liquidated and Ascertained Damages] and retention to the likes of pain/gain share has proven.

The incentivisation found in vertical governance and the collaboration of horizontal governance can be combined in partnering arrangements which unify objectives through a project level pain/gain share. Escrow or Project Bank Accounts can also be used to promote collaboration. By levying a charge to the firm, to be paid into a joint account; the money collected can be partly to reinvest in the relationship, for instance, through trust-building management tools.

A spectrum of these alignment techniques between project actors can help harness the tensions between actors to the benefit of the project; for example, a project delivered at a competitive price and of a high design quality implies the correct combination of alignment techniques applied to the main contractor and architect respectively. Correspondingly, inappropriate or incorrectly applied alignment techniques may result in opportunistic behaviour and collusion.

The reverse of incentives, the penalty system, has produced mixed outcomes in construction; it contributes to a blame culture and by it's nature diminishes a firm's impact, not always to the net benefit of firms involved across the project interface.

> "It is only because individual human beings are limited in knowledge, foresight, skill and time that organisations are useful instruments for the achievement of human purpose"
>
> (Simon, 1957, in Williamson, 1975, p.21)

The sentiments expressed by Herbert Simon above neatly frame the problem outlined in this section. The project coalitions particular to a fast-changing construction industry pose a series of specific and significant problems.

This report examines a case study to see how effective and appropriate the innovative governance mode selected [NHS ProCure 21] is to the project in question.

What is needed is a way of conceptualising of inter-firm relationships in order to draw meaningful conclusions from any analysis of them, something which is dealt with in the next section.

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[i] For the purposes of this report, we shall consider the Construction Industry as a subsection of the PBE [Production of Built Environment] sector of the economy, and our definition shall consider only UK firms undertaking *in-situ* assembly (Ive and Gruneberg, 2000, p.9) and acting within what is known as *the contracting system.* (Bowley, 1966, p.413); thus excluding speculative builders, design-and-build firms and members of BEDI [Built Environment Design Industry] and BMCI [Building Materials and Components Industry]. This narrow definition allows a range of assumptions to be applied as to the nature of governance structures, the competitive structure of the industry and the roles and influence of it's economic institutions.

[ii] The oil crisis of 1973 ended the post-1945 period of uninterrupted economic growth worldwide (Winch, 2002, p.29). The following contraction in government spending was offset by privatisation, deregulation and liberalisation of previously nationalised or monopoly markets in the hope of introducing competition and de-integration.

[iii] The Treasury's current fiscal rules include 'the golden rule', that, on average over the economic cycle, the government will borrow only to invest and not to fund revenue expenditure and the 'sustainable investment rule', that public sector net debt as a proportion of GDP will be held at a stable and prudent level.

[iv] *Nash's Equilibrium* is illustrated the recent Hollywood film, *A Beautiful Mind*, in a scene where John Nash persuades his fellow academics that their individual successes with women in a bar can only be guaranteed by the tacit acknowledgement of each other's strategies, and consequent adjustment of their own strategies to accommodate the games of others; resulting in positive results for all. Application of such a trust-orientated approach to the buyer-seller relationships in construction can help contractors deliver such "Win-Win" results as a minimum outcome.

3.0 The conceptual framework

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The report's *scope* draws on themes common to key research in the fields of management, economics, sociology and the study of the built environment. The tension between the value and scope of the report is addressed in the careful selection of a single suitable case study project and by the rigorous compilation of enquiries.

The *focus* of the report is at the inter-firm, intra-project-coalition level within the UK construction industry. Whilst analysing inter-firm alignment, the focus will not exclusively be on congruence at a general level, as this approach neglects the balance of power in the market and the more subtle aspects of inequality, inequity and equilibrium within alignments.

The *topic* of this report relates to ideas from the fields of project management, intra-coalition networks, construction economics and sociology.

The *theory* related to the topic is the *social network theory of project governance* (Pryke, 2004a), which itself represents several systems of interrelated ideas. A coherent analysis of the topics this powerful and emergent field of theory deals with is gained through the pursuit of a pertinent case study.

The *corollary* derived from this theory is that a project coalition can be seen as a defined system of objects (people, groups and organisations) joined by a variety of relationships and that the causes and consequences of the structure and patterning of these relationships over time has a defining impact on project outcomes (Pryke, 2004a).

The report's analysis uses the *analogy* of a social network of individuals as a basis for understanding how firms might relate to one another at the intra-coalition level.

The *key hypothesis* formed about this corollorary is that the effectiveness and appropriateness of NHS ProCure 21 in projects is evidenced in the particular social network structures of a project coalition. The choice of this hypothesis flows directly from a specific interpretation of how social networks operate.

Accordingly, the *null hypothesis* is that the features of social networks taken from the project studied do not imply that ProCure 21 has a significant impact on the project coalition.

The *problem-holders* are the members of the project coalition (the primary problem holder would be the client). In acknowledging their situation, those involved in UK construction may be able to

move to more reflective and realistic business models built upon a detailed appreciation of the truths about their markets.

The *research direction* is novel, standing quite separately from the main thrust of research and main body of knowledge on social networks. It's techniques contrast markedly with many of the other existing analytical methods applied to construction project activity, such as task dependency, structural analysis and process mapping approaches. There has been little research on whether corporate incentives work; and alignment mechanisms such as Pain/Gain shares and LAD's have been a neglected area of study.

> "Construction practices lend themselves to easy generalisation and mythical half-truths which, under the cloak of ... common sense, disguise serious and sometimes fundamental misconceptions."
>
> (D.A. Turin, 1975)[i]

Received wisdoms and normative theory dominate much of the debate in construction. However, they do not serve to improve our understanding of project teams. By reflecting on real-life outcomes in our research, we can move to more realistic, productive and descriptive modes of thinking and knowledge development. Theory should be designed empirically through the analysis of decisions made and activities conducted in industry (Gummesson, 2002, p.13).

The mechanics behind Social Network Analysis carry a significant degree of difficulty in their esoteric compound of mathematical and sociological techniques such as graph theory and in the sheer mass of data produced. These difficulties notwithstanding, proving the key hypothesis remains eminently feasible. This sophistication stands in contrast to the readily accessible and interpretable format of the results.

The *research objective* is to determine ultimately whether the null hypothesis can be accepted or rejected. The acceptance or rejection of this report's hypothesis may help to increase our current knowledge and understanding of the social network theory of project governance. This report represents research built upon the incremental accumulation of understanding and knowledge by past researchers; it will be undertaken with the strengths and limitations of the existing body of knowledge firmly in mind. The research can be contrasted and compared with other contemporary work and be understood as a marker for future possible research directions, prompting further hypotheses worth testing.

The NHS ProCure 21 Framework

ProCure21 is an NEC-based construction method devised by NHS Estates to meet the future demands of the UK's National Health Service.

The ProCure21 suite of contracts are employed across a programme of healthcare projects; with the aim of fostering collaborative and open project environments which will hopefully result in a high and continuously improving standard of delivery.

Launched in September 2003, ProCure21 is a departure from the traditional ways of working for the NHS, it's supply chain and ultimately, the patients. It represents a break from the traditional and familiar reward and penalty structure. ProCure21 marks a shift from lowest price [cost leadership] to value for money [differentiation of service] in its treatment of 'soft' issues.

Traditionally, projects were selected on the basis of objective and auditable measures for the 'hard' items such as price, specification and quality. In contrast, ProCure21's four key areas are,

- Collaborative working
- NHS to be 'Best Client'
- Design quality
- Benchmarking and performance management

(*NEC User's Group Newsletter*, April 2004)

As an emergent form of working, it's success remains to be proven, and research in this area can help to reveal and demonstrate it's merits, risks and possible areas requiring improvement or further development.

The P21 framework satisfies not only Recommendations 12 and 15 of The Latham Report (Latham, 1994) respectively in it's use of framework agreements for contractors (Principal Supply Chain Partners), designers and suppliers (Principal Supply Chain Members), but also Recommendation 11; that clients should begin to use the NEC suite of contracts.

The core requirements of P21 including supply chain integration, early involvement and innovation. As such, it should be the leading example of collaborative working in the UK CI (*Building*, January 21st 2005); it is already delivering cost savings in the order of 10% per cent (National Audit Office report, *Construction News*, August 11th 2005) and significant programme savings by forming project coalitions through early negotiation rather than via traditional, more adversarial routes.

P21 is intended to be used on any non-PFI, non-LIFT, publicly-funded healthcare scheme worth more than £1m. It consists of 11 contractor-led consortia, each of whom have completed a lengthy courtship and selection process to get on the approved list; they have all demonstrated their ability to manage supply chains and design teams (*Building*, November 12th 2004).

The literature provides comprehensive descriptions of the theoretical basis of using frameworks in contracting; reproducing this material here does not fall within the remit of this paper. It is more relevant to note the relative paucity of studies on NHS Procure 21 projects, highlighting the struggle of theorists to keep up with rapid pace of practitioners in this emergent field. The current debates are concentrated around whether Procure 21 is an appropriate alternative to traditional or PPP routes; rather than understanding Procure 21 as a valuable option in its own right.

The ProCure 21 framework confronts the engrained problems of the UK construction industry head-on through the introduction of deliberately incremental trust-building measures. Central to the P21 is the existence of an integrated project team. Trust, in this instance, is consolidated through relationship building and increasing quality of contact and communication. The framework agreement applies a time-frame to its alliances and involves a panel of suppliers to deal with issues of suitability, capacity and maintenance of trust.

Unlike the bespoke contracts found in PFI and LIFT, P21 has a standard form of contract; a form of the ECC [The Engineering and Construction Contract] specially modified for the NHS ProCure 21 Framework Agreement. This is an implicit recognition that project management techniques have advanced at a faster rate that the evolution of contractual forms.

The contract is valued by construction practitioners for it's clarity and focus on achieving project objectives – it avoids long sentences and ambiguous phrases (e.g. 'fair', 'reasonable', 'opinion'). Clause 10.1 of the contract summarises the intent behind NEC,

> "The Employer, the Contractor, the Project Manager and the Supervisor shall act as stated within this contract and in a spirit of mutual trust and co-operation."
>
> (*The Engineering and Construction Contract.* ICE, 1995)

Far more than a simple spot contract, ProCure21 achieves hierarchical effects through specifying authority systems, dealing with incentives between project actors, administering a pricing system, making provision for conflict resolution and has 'standard operating procedures' (see Stinchcombe, 1990, cited in Pryke, 2004a).

An early warning and mechanism facilitates an ongoing approach to items impacting on programme, cost and quality. The compensation event mechanism seeks to properly compensate the contractor when the employer's risk events occur, based on actual cost rather than bill rates.

The actual cost plus a fee (comprising overhead and profits plus other costs) is reimbursed to the Principal Supply Chain Partner during the works and there is a guaranteed maximum price set as the final target cost, which includes any compensation events. Payments to the PSCP are made on an net cost, earned value basis [adjusted for inflation and compensation events].

Any savings on the target cost are shared in a pre-agreed proportion between the PSCP and the NHS trust client, and the open book accounting principles create a transparency in which contractors must declare all such savings. Savings can add a maximum of 10% [on the target cost] to the contractor's margin.

The emphasis on providing cost and programme foresight through heavily prescribed contract administration procedures relates to the perception amongst modernisers that the value of certainty of delivery outweighs the costs of unanticipated cost uplift.

An unusual feature of P21 is that the authority to change the works information resides exclusively with the Project Manager [Clause 14.3] The Project Manager must be a named individual, whose authority can only be delegated after notifying the contractor [Clause 14.2]. A consequence of this approach is that the Employer may not direct, instruct or interfere with contractors, designers and supply chain members directly, but should pursue their project objectives through communication with the Project Manager.

Supply chain members are compensated upon substantiation of delay time, delay costs, physical costs and disruption costs; this keeps project members away from dispute, adjudication, arbitration and litigation. Disallowable costs are waste, under-utilisation of resource and snagging costs; this should act as incentive for contractors to perform efficiently.

There are no provisional sums and procedures for dispute resolution, contract termination, payment assessment and compensation event assessment and instruction. There is also no provision for either a 'hard' or 'soft' FM [Facilities Maintenance] element within ProCure21, an omission which has significant operational implications for the client.

The problems of ProCure21

A quandary which exists with both 'open-book' accounting and the benchmarking required under ProCure21. Conceptually, trust and accountability are in conflict. A cultural obsession in

construction with blame and compensation has, in the past, been characterised variously by litigation, benchmarking, 'open-book' accounting and quality assurance tools. This perpetuates the myth that one can have total guarantees of others' performance (O'Neill, 2002). Such bureaucratic measures aimed at increasing 'transparency' or 'accountability' can asphyxiate trust and represent heavy transaction costs.

Framework agreements such as P21 can sometimes become rafts of uneasy alliances, binding companies into uncomfortable, dysfunctional and crisis-plagued relationships *(Building*, November 12th 2004) when the classical problems of *hold-up, moral hazard* and *adverse selection* are not properly mitigated against within the set-up of the project (i.e. the choice of contract, communication protocol, risk, change and value management processes etc.). Major failures in communication on both sides can result in mutual failure to understand the needs and expectations of others (*Building*, January 21st 2005).

The key challenge that public sector clients, such as NHS trusts, face is in aligning their internal processes with their business objectives (*Building*, January 21st 2005). ProCure 21 covers only a part of the capital development process, and projects are often hamstrung by delays in the process immediately preceding the ProCure 21 input.

Social Network Analysis

This research uses a technique called *Social Network Analysis*, which is way of modelling construction projects as a system of firms joined by a variety of relationships, be this through contracts, shared risks, information flow or performance incentives. *SNA* has its origins in sociology and anthropology.

The technique has, in recent years, been used successfully by other sectors in a variety of circumstances, such as helping to map and break up *al-Qaeda* terrorist cells (Farley, 2003), identifying how dolphins form communities (Lusseau and Newman, 2004) and mapping the spread of sexually transmitted diseases in young adults (Bearman *et al*, 2004).

It allows the simultaneous overlay of relationship types; complex mathematical processes are neatly summarised by easily interpretable sociograms, which often produce counterintuitive conclusions that 'common sense' or experience alone would not suggest.

Some examples of social network analysis

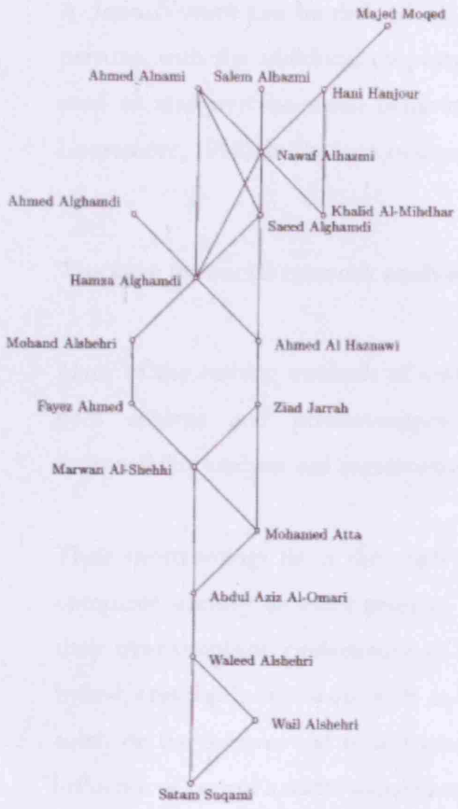
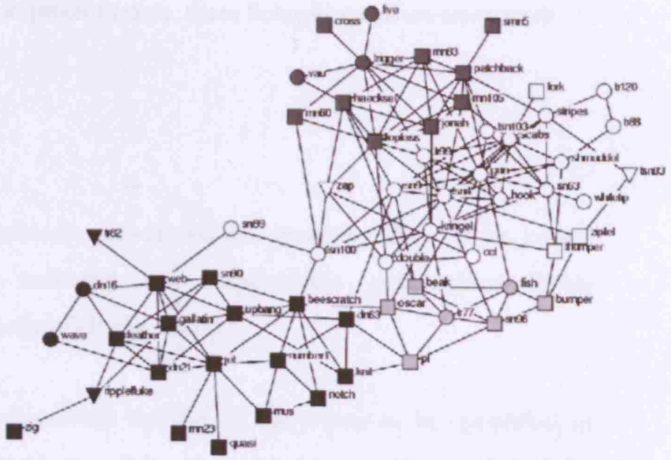


Figure 3. A graph illustrating some of the relationships between the alleged September 11 hijackers (Krebs, 2001).

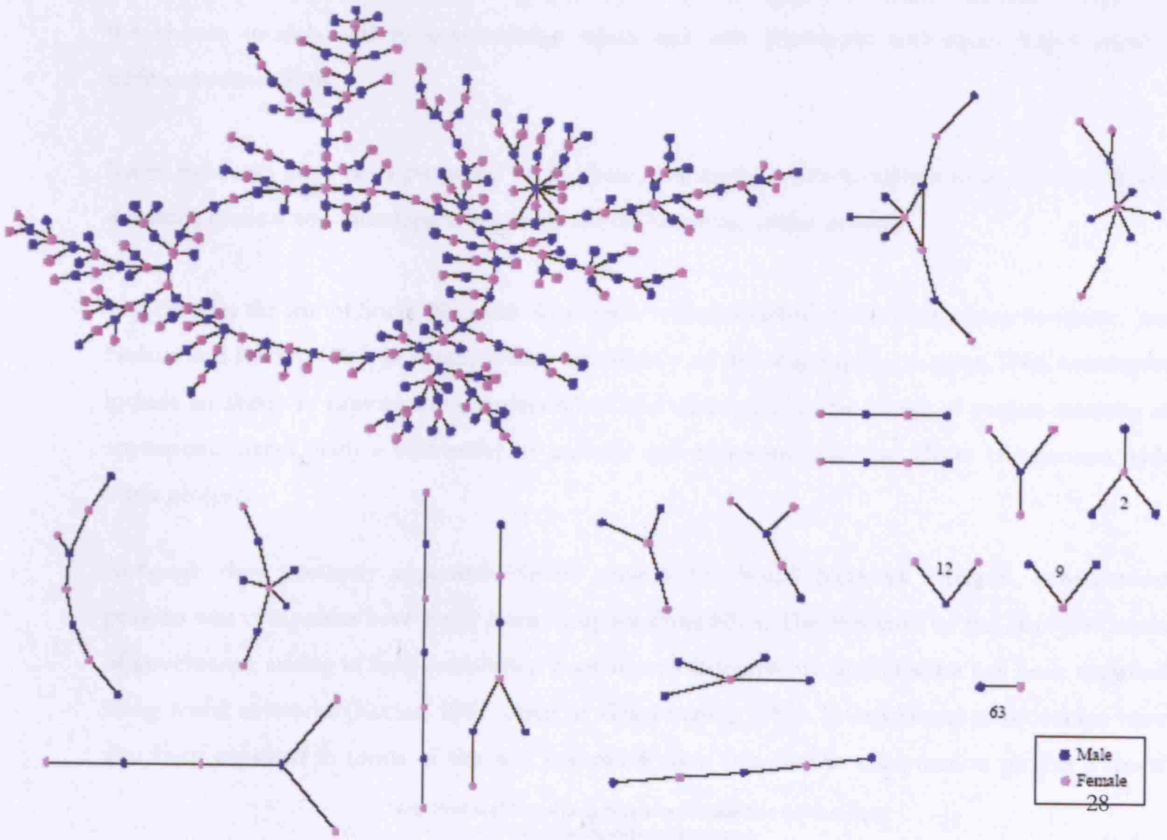


Left: **Al-Qaeda terrorist cells** (Farley, p.3200 3)

Right: **Communities of bottlenose dolphins** (Lusseau & Newman, p.3 2004)

Bottom: **Sexual behaviour of high-school students** (Bearman *et al*, p.43 2004)

Figure 5. Structure of Romantic Relations at "Jefferson High"



A *Social Network* can be defined as, "a specific set of linkages among a defined set of persons, with the additional property that the characteristics of these linkages as a whole may be used to interpret the social behaviour of the persons involved", (Mitchell, 1969, p.2, cited by Loosemore, 1998). In the case of construction project teams, these linkages are often temporary.

The case for social network analysis

Many of the existing methods of analysing projects use systems and processes (flow charts, critical path analysis and process-mapping) or authority and responsibility relationships (linear responsibility analysis and organizational structures)(Pryke, 2003).

Their shortcomings lie in their lack of detail and the inability of the results to be quantified or compared usefully to other projects. The linear approaches in particular have been criticised for their over-simplistic explanations of sociological scenarios; these are especially unsuited to new, hybrid organisational forms such as ProCure 21 project teams. Linear-based research can focus solely on the receiver and at only one point in time (Loosemore, 1998), meaning that the dynamic influence of people's wider social networks is neglected.

However, for reasons of brevity and focus, the scope of this paper does not extend to a detailed comparison of linear and process-based perspectives on projects versus Social Networks. It is enough here to apply simple modelling appropriately, to recognise the limitations and strengths of the chosen models and to acknowledge when and why alternative techniques might prompt different conclusions.

Social networks have been proposed as an alternative method which reflects more realistically the dynamic, cyclical and interdependent nature of the communication process.

The case for the use of Social Network Analysis is well established in the mainstream literature. (see Nohria and Eccles, 1992, in Pryke, 2004a) Specifically, in the construction context, SNA's strengths include an ability to capture the interdependent and often non-dyadic nature of project working in appropriate detail, with a uniformity of analysis and representation that allows comparison with other projects.

Although they presently apparently fertile ground for Social Network research, construction projects and companies have rarely been analysed using SNA. The existence of the *quasi-firm* mode of governance arising in long-established contractor-subcontractor relationships has been explored using social networks (Eccles, 1981, cited in Granovetter, 1985). Interpersonal relationships have also been explored in terms of the way communication structure in construction project impacts

upon crisis management efficiency (Loosemore, 1998). Issues of collusive practices in Italian contracting were highlighted (Soda and Usai, 1995, cited by Pryke, 2004a) when Social Network Analysis revealed construction contractors with a far greater prominence than their size (consider this an approximation of capacity and capability) would suggest; in the terminology of SNA, their centrality/size ratio was outside of expected values.

In construction, this research method has, in recent years, been used across a range of building, procurement and contract types (e.g. JCT Traditional and Design & Build, Prime Contracting, PFI) in the UK, France, the USA and China to great effect (Pryke, 2004c and 2004d).

For this report, an understanding of how NHS ProCure21 impacts upon project coalitions can be gained by examining the characteristics of their social networks; networks will differ in terms of density, the arrangement of sub-groups, positioning, point centrality and connectivity (Pryke, 2004b). Essentially SNA can enable, in this instance, the quantitative evaluation of the effectiveness and appropriateness of contractual arrangement on project coalitions.

The use of Social Network Analysis may help us to judge how *mature* ProCure 21 is as a governance model (Pryke, 2004a).; this can be measured quantitively by assessing how near our case study is to an equilibrium position (in which each of the key functions of contract, performance incentives and communication carry equal weighting).

The networks examined in this report will be the *Contractual* (the traditional, structural way of mapping project coalitions), *Financial incentives* (important in terms of explaining the changes in activity of project actors) and *Communication* (a measure of the impact that management tools have on roles and responsibilities) networks. The communication networks will be sub-classified into *Cost, Risk, Design* and *Progress* management, in order to add another level of detail and meaning to our analysis.

Key Terms

A wealth of specialist SNA terms exists to describe both the network as a whole and individual actors and their role within the network (Pryke, 2004a). These descriptors define the link between the complex network data and everyday terms used to describe networks such as social role, social position, group, clique, popularity, isolation, prestige and prominence.

The analysis of this research examines the inter-firm contractual, financial and communication relationships within a construction project. These relationships are analogous both to physical connections (such as roads, rivers or bridges) and to *ties* existing within networks of individuals; such as sense of community and hierarchy (Granovetter, 1976), opinions (friendship, liking or

respect), transactions (lending, or borrowing things), behavioural interaction, movement (migration, social or physical mobility) and biological relationships (Wasserman and Faust, 1997, cited by Pryke, 2004a).

An *actor* is a discrete individual, corporate (the definition taken for this report), or collective social unit. A collection of these *ties* of a specific kind amongst *actors* is called a *relation* (Wasserman and Faust, *ibid.*). The *density* of a network can be treated as a measure of group cohesion, this density is the ratio of the number of ties observed in a network to the number theoretically possible (Granovetter, 1976). The analysis of sociograms produced in this report will primarily focus on *density* and on the [point] *centrality* of actors within a network..

Other critical parameters of networks (Bearman *et al*, 2004) relate to the distribution of network components (sets of interconnected firms), factions (Loosemore, 1998) or groups, the presence or absence of cycles (closed loops that could generate a core if of sufficient size), and the mean length, density, and reach of the ties that bind the actors.

This report's research connects firmly with many parts of the wider body of construction economics and management knowledge, theory and debate, whilst at the same time employing some elements of innovative research methodology and acknowledging the contradictions and gaps within current thought

The multi-facetted nature of the study allows a range of perspectives and ideas[ii] to be drawn upon, from *principal-agency* theory to *transaction cost* theory, Abraham Maslow's *hiearchy of needs* (1954) and Victor Vroom's (1964) *expectancy* theory research on work and motivation.

This section has outlined how a conceptual framework appropriate to our enquiry was arrived at, drawing out the tensions between the size and difficulty of the research problem and the practicalities of data collection within the scope of this report.

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[i] Turin, D.A. (1975) *In Aspects of the Economics of Economics*, London: Godwin. (Cited by Chang and Ive, 2004).

[ii] **Links to construction economics and management knowledge, understanding and debate**
The Social Network Analysis used in the research allows 'soft' [relationship management] and 'hard' [information processing] aspects of *project management theory* to be interrogated simultaneously, key aspects central to effectiveness and efficiency respectively.

The principles of *enterprise management* are explored in the report by examining how strategic and operational challenges relate to both project effectiveness and competitive advantage in the market. Specifically, Social Network Analysis raises issues of organisational design, of motivation, of transaction costs and relationship management.

The situation for construction clients face in the *market for contracts* can be understood by relating construction project social networks to ideas about trust and relationship management, client loyalty and the transaction cost framework.

ProCure21 is an innovative form of public sector procurement, but stands apart from the modern procurement routes such as LIFT and PFI in its absence of private sector funding. The *privatisation of infrastructure* is a key issue for observers of the built environment, and using Social Network Analysis to assess the economic and social aspect of project teams relates to key questions about efficiency of public services and may point to whether public sector projects are best suited to centralised public management or a combination of both public money and private equity involvement.

This report deals with a key area of enterprise management, that of *relationships between firms* be they clients, contractors, consultants , subcontractors or suppliers. Analysis of project teams can reveal how the tensions of reconciling project with corporate performance are addressed in differing ways across a project coalition. Aspect of the underlying theory are drawn out (concepts of trust, virtual and temporary multi-organisational teamworking) and the push to improve co-operation across key players understood as a set of managerial tools (e.g. risk/value management), deployed with varying degrees of success.

In particular, this report also provides an opportunity to examine the relationship at key juncture of the supply chain; *the contractor-subcontractor relationship*. Implications include the exploration of make-buy boundary management, subcontractor framework agreements and performance management of subcontractors in purchasing and supply chain management approaches.

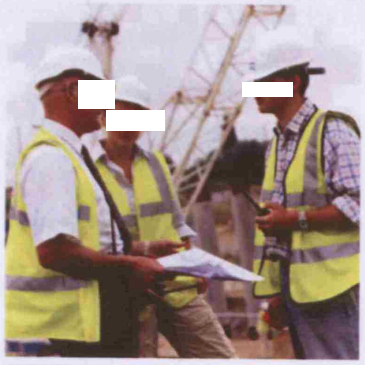
The traditional contracting system of adversarial relations, competitive tendering and fragmented roles is described and the co-operative routes using negotiation, partnering and non-adversarial alliances are identified as possible alternative systems.

The report's focus on *organisations and people in project-driven enterprises* helps us to understand, analyse and apply to the case study the following,

- The nature and structure of project-based organisations.
- The opportunities and problems arising in the operation of organisations in respect of power, authority, stakeholders, excluded groups (including issues in conflict and communication).
- The development, leadership and functioning of project-based teams.
- Information flows: the processes of creating, diffusing and enlarging project-based knowledge

Importantly, a concern for the *economics of construction* at both *sector* and *industry* level is implied throughout the report; this is expressed both in terms of relating findings to the efficiency, capacity, productivity and profitability of the construction sector as a whole and understanding how the research topic helps explain the unique way in which the production of the built environment is organised.

The constraints facing project-based firms imposed by specific forms of competition and market context are explored within the report; which casts light on how the *economic institutions of the construction industry* affect demand and consequently organisational structures.



4.0 Enquiry and data collection

4.0 Enquiry and data collection

This section describes the case study and primary data collection methods and explains the format and reasoning structure of the enquiry process. The evidence is sourced from a live construction project, the descriptive questions addressed in the analysis of real situations rather than solely through literature review or via existing normative models.

The case study

The case study is an example of innovative procurement and comprises an new, world-class, specialist international children's hospital erected on a "brown-field" site for a central London Hospital NHS Trust.

The Client, an NHS Trust, currently provide a unique national and international treatment, research and teaching resource. The range of specialist services and volume of patients offered is unrivalled by any other institution in the world, with over a quarter of a million attendances each year.

The scheme is approximately 4,000m^2 and consists of seven floors incorporating outpatient and day case areas, a paediatric research unit, waiting area, café and hostel accommodation for patients and their families. The site, previously nursing accommodation owned by the Client, was demolished to provide space for the new facility.

The design team, led by a high profile architect, set out to create an uplifting design and strong identity, with an emphasis on light and space, creating a welcoming and child-friendly environment, with key areas linked to the main hospital site, offering direct access for staff and patients.

The key elevation has a striking and attractive appearance forming the public face of the building. An architectural palette of curtain walling with glass-sculptured louvres provides *brisé-soleil* style solar protection, creating a distinctive animated façade. The new structure is of a reinforced [flat slab] concrete frame construction, with brickwork and curtain walling to the façade and a flat concrete roof.

It is important to note that, whilst the NEC suite of contracts and the management approach used on the case study might be seen as comprising *innovative procurement* and *lean management* respectively, the project relied on relatively commonplace and established construction methods and products rather than *modern methods of construction*. This is not to say that some innovation was not used; plant

rooms were assembled off-site and a new formwork system used in frame construction in order to make programme savings.

The *Client*, an NHS Trust, employed managers from a large multidisciplinary consultant to act as their *Project Manager*. *The Contractor*, or Principal Supply Chain Partner, is a top ten UK contracting organisation, with a substantial PFI and PPP workload.

The *Quantity Surveyor* role on this project was set up in very unusual manner. A single quantity surveyor was appointed by the contractor for *joint* use as a cost manager by both contractor and client. This replaced the traditional 'man-marking' arrangement on projects, whereby a client uses a project quantity surveyor and the contractor also uses [in-house or outsourced] cost management. This was a bold step by the project team as, whilst ProCure21 aims to foster collaborative and trusting environments, it stops short of prescribing such arrangements. It is also a potentially source of significant cost savings; as quantity surveyors do not *build* anything, they represent a pure transaction cost. Employing one less quantity surveying firm can save costs and time lost in administrative processes and disputes. Social Network Analysis may help us to understand how these intentions were manifested in reality.

Principal Supply Chain Members

The *design supplier team* comprised of a high profile prize-winning architect, a multinational building services engineer and a well-respected medium size structural engineer. Specialist disciplines such as acousticians, fire engineering and environmental engineers were contracted via the principal designers.

Key supply chain members included the mechanical and electrical contractor (a P21 PSCM), the façade subcontractor and the concrete frame subcontractor.

The commercial process

The contractor's involvement begins at the start of the second phase (of four), when the trust's funding has been secured for the scheme (Outline Business Case approval). The trust call interested P21 contractors to interview and the successful contractor is notified, appointed and in contract within the four days following interview. Phase Three then begins, in which the contractor directs a team of designers and key supply chain members to progress the design to a level where a GMP can be reached which is within acceptable cost certainty parameters (Full Business Case). This GMP then forms the target price from which the PSCP and the PSCM team can complete the design and construction (Phase Four) of the new facility.

Procedure

A somewhat esoteric and emergent research field, Social Network Analysis has yet to develop a single agreed approach within the literature to data collection (Pryke, 2004b).

For this report, data were gathered using structured interviews (to establish context) and inspection of documents (to establish relational characteristics). The interviews and document inspection combine to establish the networks of contractual relationships, performance incentives and communication networks for cost, risk, progress and design management.

The Project is sampled across a number of [entire] networks, with one key relational or personal characteristic sampled per network.

Within the framework of the key functions, data were collected using a modified version of linear responsibility (Pryke, 2004b). In this format, the network data were in node list form for input into a specialist SNA analysis and visualisation software program, UCINET 6 (Borgatti, Everett and Freeman, 2002). This work, through to the production of the sociograms and an initial prognosis was undertaken by Dr. Stephen Pryke of The Bartlett School of Graduate Studies, University College London.

Once the data has been imported into the proprietary package, UCINET 6, the SNA software interrogates and describes a number of different types of relationship within a project coalition network in a mathematical and graphical format. The analysis of the output can then be based upon the point centrality and network density of key project actors within the main project functions.

The sociograms and the study itself constitutes a snapshot of a project coalition, rather than an examination over time. At the time the data was collected, the construction was 45 weeks into a 91-week programme.

Identifying population boundaries appropriately and inclusion of the whole population in data collection is essential (Pryke, 2004b). Consequently, whilst sampling has obvious logistical attractions, its use in Social Network Analysis could render the results invalid. Boundaries for the case study analysed here were established using the following criteria (established by Pryke, 2004d),

- The individual interviewee to be involved in the project.
- The individual not involved in the use of hand tools for any part of their role in the project.
- Individual to be identified by at least one other project actor.
- The link with any given actor to be significant in terms of frequency and perceived importance of input by other actors

Data were triangulated by confirming the existence of linkages identified by actors, with those actors cited by the first actor. In this way, both actors identified in a linkage had to confirm the existence and type of linkage before the linkage was regarded as valid; send and receive communication links being considered separately (Pryke, 2004d). Each respondent was invited to identify their networks and the standard classifications for communications (cost, design, risk and progress) were prescribed. This validation process helps the analysis remain objective and allows actors to be categorised as transmitters or receivers (Pryke, 2004d).

The questionnaire and research briefing given to those participating in the study are enclosed within the appendices of this report [*Section 9.0*].

Initial analysis of the data set for the construction project should produce variations in network density and point centrality values. These differences can be observed be inspecting and comparing of sociogram diagrams produced through the *Draw* feature within the software. The data is presented in tabulated form or 'node list' form initially, this information is presented as an appendix to this report [*Section 9.0*].

5.0 Analysis and interpretation of results

5.0 Analysis and interpretation of results

The preceding sections have dealt with the mechanisms, key terminology and differentiating characteristics of Social Networks. Also explained in detail was the ProCure framework and the main features of the case study project.

The primary data collected is analysed in this section of the report and the results interrogated for accuracy, relevancy and value. Interpretation of empirically-observed results enables us to identify some significant and substantial findings [where they occur], commensurate with the size and degree of difficulty of the research problem. The analysis and investigation methods chosen have been employed in a manner appropriate to the problem's context and applied meticulously.

The analysis following consists of the visual interpretation of the network sociograms for network density, grouping, specific ties (or absences thereof) and actor centrality. It must be noted that this becomes more difficult for networks containing a high number of links, that is to say, networks demonstrating high *connectivity*. Inspection of the network sociograms may reveal a number of interesting aspects, these being,

- Use and relevance of financial incentives in the governance of the project
- Emergent and redundant project actor roles
- The effects of the use of clusters and SCM
- The effects on project governance of a reduced reliance on contract for project governance
- The role that financial incentives have in shifting roles and specific responsibilities within roles, between project actors

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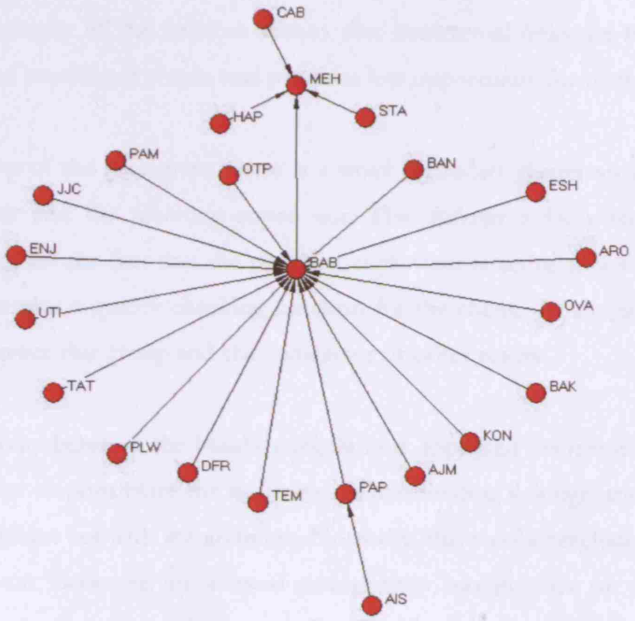
Procure 21 Case Study

Contractual Relationships Network



Key to Actor Roles

Ref.	Activity
AIS	BUIDING R GUATIONS I NSPECTOR
AJM	CONCRTE WORKS SUBCONTRACTOR
ARO	AK CONSUL ANTS
BAB	PRNCIPA ISUPPKCHA IN PAKNER
BAK	M &E SUPPKCHAIN MEMBER
BAN	BRCK &BOCKWOK SUBCONTRACTOR
ENJ	SCADDING SUBCONTRACTOR
CAB	PANNING SUPEKSOR
DR	ABOUR
ESH	JOIN EKUN ITS SUPPIER
HAP	CIENT' S RPRSENTA TIVE
JC	EAKHWORKSDRAINAGE SUBCONTRACTOR
KON	IFS SUBCONTRACTOR
MEH	CIE NTE ND USERSP21 ENDING
OTP	E.G. PAKY WAL RGHTS OHGHT
OV	SEKCES CONSULANT & ACOUSTICIAN
PAM	STECT CONSULANT
PAP	ARCHITECTUR L SEK ICES
PW	CUKAIN WALLING
STA	PANNING , ENGISH HE R TAGE
TAT	COST CONSULANT
TEM	TEMPOR RY EECTRCS
UTI	COMMSGASEECOIV TERPROVIDER

Contractual relationship network

Most firms are connected to one actor: the Principal Supply Chain Partner or main contractor. This is reflected in higher levels of *centrality* within the contract network for the PSCP. Centrality here provides a measure of prominence or influence.

The low connectivity of the network means that contractual links are focussed upon a relatively small number of prominent actors, and provides less opportunity for contractual disputes.

Towards the top of the sociogram, there is a small secondary cluster around the client, the client's project manager and the planning supervisor. This follows a fairly straightforward client team structure, except for the fact that the planning supervisor is acting in a statutory CDM role, which indirectly constitutes a quality checking function for the client. It is logical that there is no privity of contract between this group and the contractor or other actors.

There is no privity between the building regulations approved inspector and the main contractor, implying that the responsibility for making sure the building's design and construction is building regulation compliant lies with the architect. Normally, this would preclude leverage of the inspector by the contractor. However, an unusual arrangement was in place on this project, whereby the building inspector was appointed, instructed and paid solely via compensation events raised by the main contractor, thereby mitigating against any possible lack of direct contractual clout.

The contractual set-up of the project under ProCure 21 was such that the NEC suite of contracts was used universally across the project coalition, from *the black book* between the client and the Principal Supply Chain Partner to *the orange book* (the professional services contract), *the turquoise book* (short-order subcontract) or *the purple book* (subcontract contract).

This helps explain the relatively straightforward structure of the contractual network as opposed to the complicated multi-layered subcontracting arrangements found in many construction projects.

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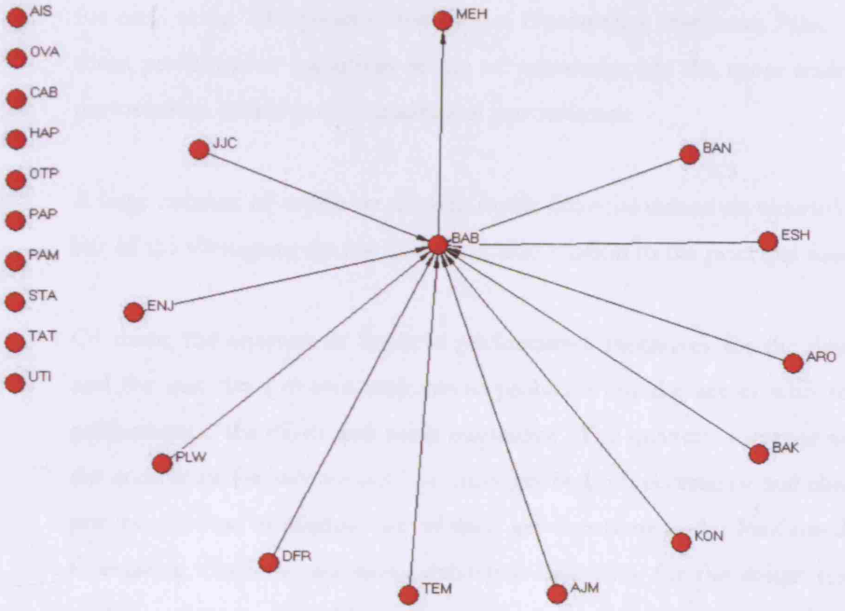
Procure 21 Case Study

Financial Incentive Relationships Network



Key to Actor Roles

Ref.	Activity
AIS	BUILDING REGULATIONS INSPECTOR
AJM	CONCRETE WORKS SUBCONTRACTOR
ARO	ART CONSULTANTS
BAB	PRINCIPAL SUPPLYCHA IN PARTNER
BAK	M &E SUPPLYCHAIN MEMBER
BAN	BRICK &BLOCKWORK SUBCONTRACTOR
ENJ	SCAFFOLDING SUBCONTRACTORS
CAB	PLANNING SUPERVISOR
DFR	LABOUR
ESH	JOINERYUN ITS SUPPLIER
HAP	CLIENT'S REPRESENTATIVE
JJC	EARTHWORKS/DRAINAGE SUBCONTRACTOR
KON	LIFTS SUBCONTRACTOR
MEH	CLIENT/END USERS/P21 FUNDING
OTP	E.G. PARTY WALL, RIGHTS OF LIGHT
OVA	SERVICES CONSULTANT & ACOUSTICIAN
PAM	STRUCT CONSULTANT
PAP	ARCHITECTURAL SERVICES
PLW	CURTAIN WALLING
STA	PLANNING, ENGLISH HERITAGE
TAT	COST CONSULTANT
TEM	TEMPORARY ELECTRICS
UTI	COMMS/GAS/ELEC/OIL/WATER PROVIDERS

Financial incentive network

Examination of contract documents and interviews with over forty of the managers involved with the project enabled us to establish how incentives between firms were both [tacitly and explicitly] organised and make a set of assumptions about the consequences of over and under-performing for each actor. The project employed a Guaranteed Maximum Price (GMP) with shared savings, these performance incentives acting as substitutes for the more traditional LADs, retention and performance bonds used in traditional procurement.

A large number of *isolates* are evident in the financial incentives network; each of those listed on the left of the sociogram are not incentivised in relation to the principal functions of their role.

Of these, the absence of financial performance incentives for the designers, the project manager and the quantity surveyor may create problems for the actors who rely most obviously on their performance, the client and main contractor. The quantity surveyor was, unusually, appointed by the contractor for *joint use* as a cost manager by both contractor and client. Unfortunately, the QS is not incentivised in relation one of their key functions under ProCure 21, the accuracy of financial forecasting. Similarly, the non-contractual incentives for the design team to perform (in terms of quality and pace of production) appear weak, which exposes the contractor to a risk of poor performance by the designers.

The PSCP, or main contractor, has a very high level of centrality within the contract network. In fact, this is an example of the highest possible value for centrality, if the isolates are ignored. The main contractor could not have a higher level of connectivity with the group of *non-isolate* project actors. It is suggested that the use of a GMP leads the contractor to be more direct and proactive in client, budget-related cost control, the contractor's sole source of incentive being the client.

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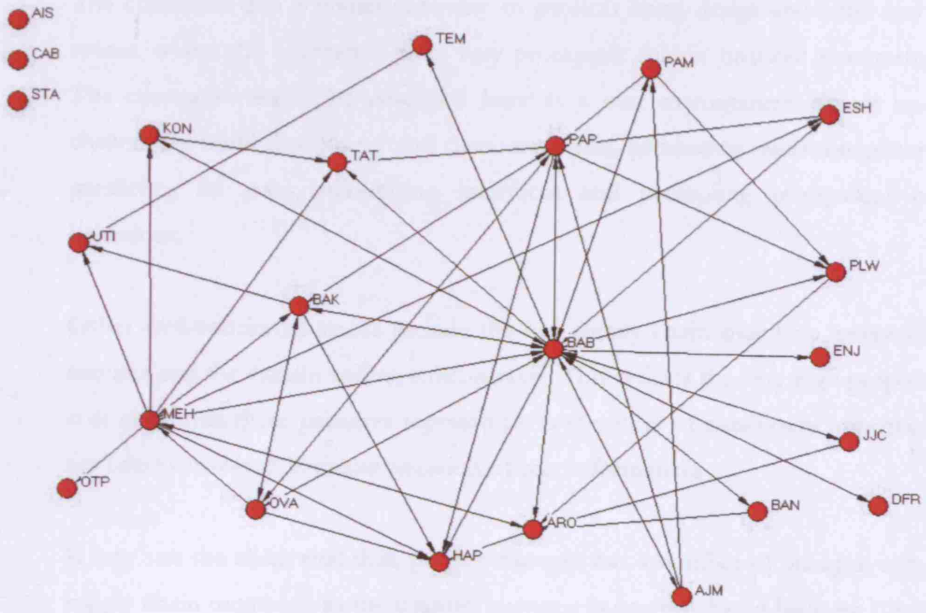
Procure 21 Case Study

Communication Network - Costs



Key to Actor Roles

Ref.	Activity
AIS	BUILDING REGULATIONS INSPECTOR
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ARO	ART CONSULTANTS
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TEM	TEMPORARY ELECTRICS
UTI	COMMS/GAS/ELEC/OIL/WATER PROVIDERS

Communication networks: Cost management

The cost management network contains very few isolates, which means that whole coalition is at some level engaged in financial management; a positive sign, that all actors are involved in cost control.

The contractor has a similar centrality to projects using design-and-build and GMP procurement routes, where the contractor plays very prominent role in financial monitoring and management. The contractor might be described here as a cost management cluster leader, where projects clusters are multi-disciplinary and democratic sets, promoting multi-disciplinary working, enabling paralleling of tasks, minimising interfaces and promoting transparent communication and behaviour.

Other well-connected actors include the key supply chain members responsible for the building services and the curtain walling subcontracts. This reflects the very high proportion of the net build cost value that these packages represent; it is therefore of paramount importance that these actors are heavily involved in communication of cost information.

It may suit the client that their project manager has a number of linkages with both designers and supply chain members, as the quantity surveyor (a service shared between Client and Contractor in an unusual arrangement) is very weakly connected. The QS may struggle to gather sufficient information to provide early warning and proper management of costs to the client. An actor as poorly connected as this can only ever offer cost monitoring and this is likely not to be timely. The emphasis in ProCure 21 on providing cost and programme foresight is relayed through heavily-prescribed contract administration procedures. The suggestion is that the QS's ability to perform this role adequately is both hampered by and a cause of their weak connectivity in the cost management network.

The low amount of isolates, bridges and dyads demonstrates the interdependent and multidisciplinary nature of the modern project working process.

Alone amongst the design team, the relatively low level of centrality for the structural engineer is surprising and indicates a possible lack of integration, which could result in cost overruns for the project if failure to communicate cost information relating to structural items (e.g. inflation of steel/concrete prices outside expected limits, extent and nature of temporary works, secondary steel design) occurs consistently.

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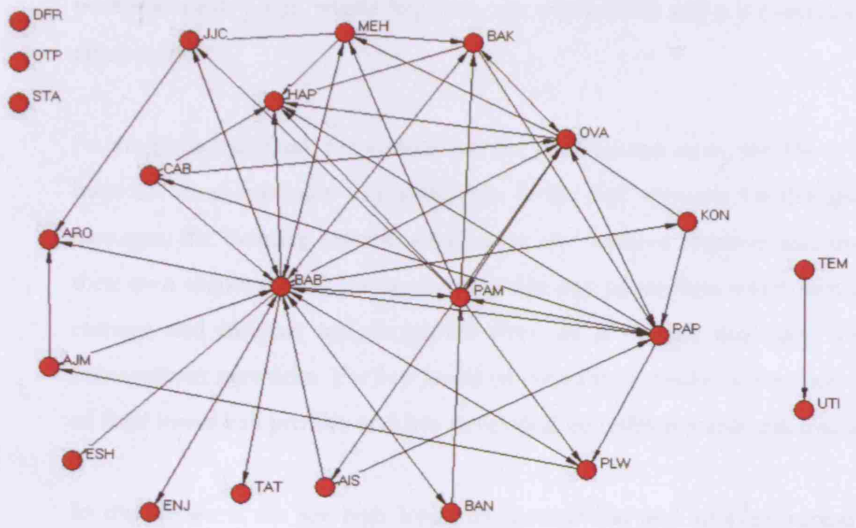
Procure 21 Case Study

Communication Network - Risk



Key to Actor Roles

Ref.	Activity
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TAT	COST CONSULTANT
TEM	TEMPORARY ELECTRICS
UTI	COMMS/GAS/ELEC/OIL/WATER PROVIDERS

Communication networks: Risk Management

This network correlates with the cost and progress networks in its lack of isolates, which means that much of the coalition is engaged in management of, or at least discussion about, risk.

The dyadic relationship between the temporary electrics subcontractor and the utilities may be a potential weak point, where key risks are overlooked and not communicated, shared or managed appropriately.

As might be expected, the contractor, the professional team, the client and the key subcontractors have the most centrality or prominence in the risk network. Of this group, the client, the project manager, the building services contractor, the services engineer and the main contractor all have their own corporate risk management policy and procedures which aim to capture, record, allocate, manage and mitigate against known risks; so it follows that they would feature highly in risk management networks. The low levels of centrality for other actors may be explained both in terms of their lower risk profiles and less developed attitudes towards risk management.

In this network, we see high levels of connectivity and an even spread of centrality between the actors, showing a balanced prominence of specialist contractors within information exchange networks.

The fact that most respondents considered themselves (and their networks) to be involved in risk management reflects two things; that the progressive management approach enshrined in ProCure 21 has been well-communicated and implemented across the project coalition, and that the question respondents answered was relatively open-ended in it's classification of risk-related communication (rather than the narrower definitions of risk management i.e. the use of quantative tools such as Monte Carlo and optimism bias etc. used in PFI, PPP and corporate finance control terminology).

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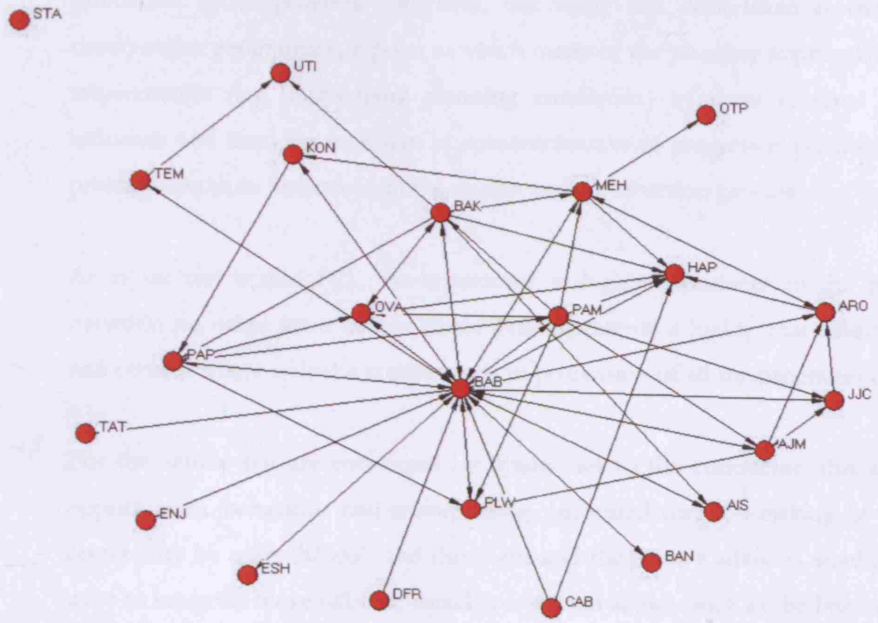
Procure 21 Case Study

Communication Network - Progress



Key to Actor Roles

Ref.	Activity
AIS	BUIDING R GUATIONS I NSPECTOR
AJM	CONCRTE WORS SUBCONTRACTOR
ARO	AR CONSUL ANTS
BAB	PRNCIPA ISUPPCHA IN PARNER
BAK	M & SUPPCHAIN MEMBER
BAN	BRCK & BOCKWOR SUBCONTRACTOR
ENJ	SCADDING SUBCONTRACTOR
CAB	PANNING SUPEISOR
DFR	ABOUR
ESH	JOIN EXUN ITS SUPPLIER
HAP	CIENT' S RPRSENTA TIVE
JJC	EATHWORKS/DRINAGE SUBCONTRACTOR
KON	IFS SUBCONTRACTOR
MEH	CIE NTE ND USERSP21 ENDING
OTP	E.G. PARY WAL RGHTS OIGHT
OVA	SEICES CONSULANT & ACOUSTICIAN
PAM	STECT CONSULANT
PAP	ARCHITECTUR L SEI ICES
PLW	CURAIN WALLING
STA	PANNING , ENGISH HE R TAGE
TAT	COST CONSULANT
TEM	TEMPOR RY EECTRCS
UTI	COMMS/GAS/EEC/OIL/WA TERPROVIDER

Communication networks: Progress

Only the statutory third parties such as English Heritage isolated from this network, which means that much of the coalition engaged in management of, or at least discussion about, progress. It may appear ironic that these third parties, a major source of delay on many projects, are isolated from discussion about progress. However, our study was undertaken at over halfway through the construction programme, a point at which many of the planning approvals had been gained and the requirements (e.g. discharging planning conditions) of these external stakeholders met; their influence and need for inclusion in communication of progress is possibly a lower priority for the project team than earlier within the design and construction process.

As is set out within P21, the contractor is highly prominent in the progress communication network; no other actor comes close. This represents a highly centralised system of management and control where only the contractor is in possession of all the programme information.

For the actors that are connected by dyadic ties to the contractor, this arrangement may induce opportunistic behaviour and misreporting. Informed decision-making by those firms away from centre may be quite difficult and the client and the client's advisors would be well-advised to seek ways to integrate more fully the weakly connected actors (such as the brickwork subcontractor) into progress reporting and communication, perhaps by incentivising them to do so.

Again, the designers and key subcontractors display a healthy level of prominence in a dense progress communication network.

Interestingly, the client takes a strong and direct interest in communication of progress as shown in their ties to designers, the contractor and the key subcontractor. It is worth noting that the client does not rely upon either their QS (again, extremely isolated) or their project manager to communicate matters relating to progress. This suggests that programme is a key objective for the client and may point to a lack of confidence by the client in the quality of their advisors. The irony of this is that a distinctive feature of P21 is that the authority to change the works information resides exclusively with the Project Manager [Clause 14.3] A consequence of this approach is that the Client may not direct, instruct or interfere with contractors, designers and supply chain members directly, but should pursue their project objectives through communication with the Project Manager.

There is a significant degree of correlation between the cost, risk and progress communication networks, this consistency would imply both high quality data and maturity of governance.

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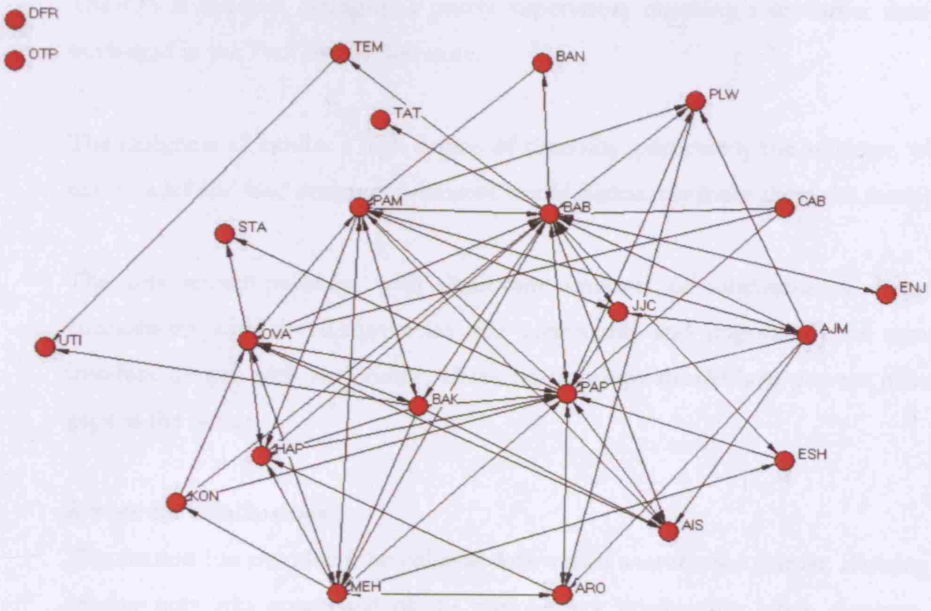
Procure 21 Case Study

Communication Network - Design



Key to Actor Roles

Ref.	Activity
AIS	BUIDING R GUATIONS I NSPECTOR
AJM	CONCRTE WORS SUBCONTRCTOR
ARO	AK CONSUL ANTS
BAB	PRNCIPA ISUPPKCHA IN PAKNER
BAK	M &E SUPPKCHAIN MEMBER
BAN	BRCK &BOCKWOK SUBCONTRCTOR
ENJ	SCADDING SUBCONTRCTOR
CAB	PANNING SUPEKSOR
DR	ABOUR
ESH	JOIN EKUN ITS SUPPIER
HAP	CIENT' S RPRSENTA TIVE
JC	EAKHWORSDRINAGE SUBCONTRCTOR
KON	LFS SUBCONTRCTOR
MEH	CIE NTE ND USERSP21 ENDING
OTP	E.G. PAKY WAL RGHTS OHGHT
OK	SEKCES CONSULANT & ACOUSTICIAN
PAM	STRCT CONSULANT
PAP	ARCHITECTUR L SEK ICES
PW	CUKAIN WALLING
STA	PANNING , ENGISH HE R TAGE
TAT	COST CONSULANT
TEM	TEMPOR RY EECTRCS
UTI	COMMSGASEECOIKWA TEPROVIDER

Communication networks: Design

In line with the other networks examined, the design communication network contains few isolates,

The client is again well integrated into these discussions; their involvement may even go so far as to run counter to the provisions of ProCure 21 and detract from the authority of the Project Manager. The QS is isolated, acting in a purely supervisory checking role, rather than the proactive role envisaged in the ProCure 21 literature.

The designers all exhibit a high degree of centrality, particularly the architect, whose brief as design team leader and lead design coordinator would necessarily make them the most prominent designer.

The subcontract packages with significant amounts of subcontractor design also have strong connections with the design team, the contractor, and importantly (in terms of detailing and interface design) with each other. These relationships should help prevent mistakes and overlap or gaps in the design.

A base for conclusions

This section has examined the collated data within a structured format, allowing us to compare and overlay networks composed of the various key relationship types. Analysis of the sociograms enables us to make a set of conclusions, which follows in the next section.

6.0 Conclusions

6.0 Conclusions

The analysis preceding this section enables us to reach a set of conclusions about the research. This section not also illuminates linkages between our findings and the wider body of construction economics and management knowledge but also points towards gaps in our understanding and highlights the strengths and weakness of our chosen research method.

The findings should help illuminate how ties and alignment work in terms of their effects on social networks and ultimately success for members of project coalitions.

Analysing networks is difficult; causation is iterative and interactive, yet we have demonstrated the viability of using SNA in the analysis of ProCure 21 projects.

Another issue is that the case study was the first ProCure 21 project undertaken by any of the members of the project coalition; an important point when linking the characteristics of the case study social networks to the P21 systems. It is difficult to establish from a study in isolation whether the networks were the product of structural factors or individual personality, capability and experience.

The shift from traditional procurement and project management processes to technical clusters and supply chain management requires one prominent actor to manage the production phase. In the case of our case study project, it was undoubtedly the Principal Supply Chain Partner or main contractor.

How mature is ProCure 21?

The use of Social Network Analysis may help us to judge how *mature* ProCure 21 is as a governance model (Pryke, 2004a).; this can be measured quantitively by assessing how near our case study is to an equilibrium position (in which each of the key functions of contract, performance incentives and communication carry equal weighting). Other signs of maturity include the incorporation of *temporary governance modifiers* (Pryke, 2004a) alongside contractual conditions.

ProCure 21's emphasis on equitable and collaborative working and accurate cost and programme reporting and assimilation of *temporary governance modifiers* such as the compensation and dispute resolution mechanisms imply a level of maturity within the governance mode.

There is a significant degree of correlation between the cost, risk and progress communication networks, this consistency suggests both high quality data and maturity of governance mode.

Changing roles

A consistent finding across the networks examined was that the quantity surveyor occupied positions of low centrality, which left the QS in a weak position from which to exert influence and to gather, process and to communicate important information in a timely and constructive fashion. Unusually, the QS had been appointed on the case study to act jointly on both the clients and the contractor's behalf; it appears this well-intentioned approach was unsuccessful in terms of securing good cost management performance. The other concern over this approach (which is not itself a P21 requirement) is that it may present problems at audit stage if cost data is only sourced by one actor, rather than the conventional testing of the contractors pricing by the project quantity surveyor.

Strengths and weakness of research method

Whilst recognising the value of examining project management issues through the lens of Social Network Analysis, our analysis must be at the same time understood against the backdrop of other part-rival, part-complementary theory and viewed as solely one mechanism of explanation in the spectrum of theory rather part of a general theory of project dynamics.

SNA at the interfirm level - a false analogy?

One possible criticism of Social Network Analysis used at the interfirm level is that to liken networks of organisations to social networks composed of individuals may be taking a misleading and erroneous perspective. It is true that the company is treated as an individual under law, giving them similar rights and protections to those we enjoy as human beings. But this may prove a false starting point from which to understand their behaviour, as in reality companies often exhibit traits more commonly associated with psychopaths or sociopaths than those of normal human beings (*The Economist*, May 6th 2004).

The logic follows, that like a psychopathic or sociopathic individual, the company is a manipulative, fundamentally self-absorbed and self-promoting entity; it's purpose is to create wealth. Companies lack the capacity for empathy or apology, and relentlessly act in their own interest while discounting the interests of others (i.e. employees, clients, the environment). Companies, in this cynical view, are inflexible and inhuman and society often finds their self-serving actions abhorrent.

The analysis that bureaucracy is inherently tyrannical is disarmingly persuasive, but ultimately misleading; it neglects, for instance, to acknowledge the roles of trade unionism and corporate social responsibility, or to admit the failings of alternative (i.e. public sector) systems of organising and directing the means of production.

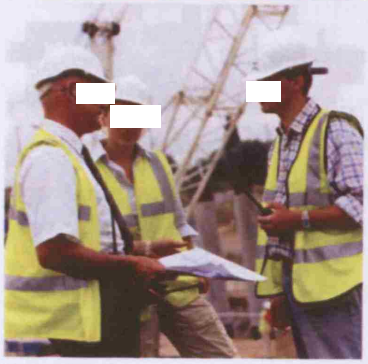
It fails the understand the imperfect, improbable and extraordinary miracle of the market; that, cumulatively, the stunted inward-looking trait [self-interest] particular to *homo economicus* can be transformed, through spontaneous social cooperation, into a force for the common good (*The Economist*, December 10th 1998). This report's use of Social Network Analyis at the interfirm level recognises that construction firms involved in projects cooperate socially in the pursuit of their own business objectives.

The paradox of progression

The last decade has been one of unstinting self-examination and self-criticism by those within the industry. The search for improvement has been concentrated mainly in the upper echelons of contracting firms. Such firms often espouse the virtues of innovation and improvement under the monikers such as *Best Practice* and *Supply Chain Management*, implicitly denigrating the practices and processes of the smaller building firms, who by number constitute a vast sector, "the long tail" of the UK construction market.

Ironically, larger contractors have much to learn from the social networks of smaller firms. The local builder enhances the quality of his service by building relationships with his customers. (Smyth, 2000, p.192). This network of customers and contacts help generate repeat business, build trust and secure new custom through recommendation. These businesses recognise that excellence in conduct is critical to their success. This is the essence of trust building, a concept that the major contracting firms are struggling to integrate in a systematic way into their strategy, at the cost of losing clients and producing disappointing outcomes for firms they deal with.

Analysis of the data collected has enabled a number of powerful conclusions to be drawn about ProCure21's effectiveness and appropriateness. This section also recognises the assumptions made in reaching these conclusions and the limitations of this report. These conclusions can now form the basis of a series of recommendations for those in industry and research connected to the built environment.



7.0 Recommendations

7.0 Recommendations

The conclusions drawn enable us to make a set of recommendations in this section. Implicit within these recommendations are both actions for practitioners within the industry and significant future research areas for observers of the built environment.

Real life is complicated and the behaviour of the CI and it's firms difficult to model. The divergent positions taken across the spectrum of construction management and economic theory describe inter-firm dynamics in very different ways, although they do not preclude this report's key arguments from being transposed and applied to specific construction industry conditions.

Actions for problem-holders, policy-makers and researchers

In practical terms, this work has specific implications for the way projects and programmes of work might be viewed, bid and managed[i] by those in construction.

Private sector involvement in ProCure 21

At the time of writing, the Department of Health's Commercial Directorate are examining ways of incorporating a private finance element into P21. There is, in contrast to recent innovations in public sector procurement, no private finance involved in P21. The private sector is often judged to be best placed to handle risks involved with design, construction and operation of an asset. It can greater design and managerial skills and efficiency, the sole tender enabling more efficient management of the Capex/OpEx split, implicitly lowering end user costs and thus the unitary charge back to the contractor.

This change would align the framework with PFI, PPP and LIFT models. Private sector decision-makers in a part-private Procure 21 would not be immune to failure, but in market conditions unstifled by government intervention, dubious decisions would show up more quickly, be accountable to shareholders and cause less damage than in the case of the failures like those at Vivendi, Parmalat, Worldcom, Tyco, Credit Lyonnais and Groupe Bull (Kay, 2004, p. 278). Indeed, the spectacular rise and fall of the profiteering and incompetent UK PFI contractor Jarvis should be taken as proof that privately-financed public procurement can work a when poor results are rooted out by keen financiers rather than tolerated by bureaucrats. More research on this option is recommended.

Future hypotheses and research

The next level of analysis

The data generated in this report has been collected, formatted and analysed in such a way that further work may reveal valuable insights into the differences between the case study and other, similarly analysed projects. As such, this report can provide a future platform for the comparison of a ProCure 21 project with the following projects (see Pryke, 2004d),

- 'The Essex Project' – UK Public Sector, *traditional* [JCT98] procurement
- 'The Aldershot Project' – UK Public Sector, *innovative* [Prime Contracting] procurement
- 'The Uxbridge Project' – UK Private Sector, *traditional* [two-stage with GMP] procurement
- 'The Slough Project' – UK Private Sector, *innovative* [bespoke, Prime Developer-Contractor] procurement
- Various projects in China and France.

Fair comparison can be made as, in order to limit the number of variables involved, this report's case study is of a similar value, construction complexity and GIFA [gross internal floor area] and storey height to the series of projects already investigated (Pryke, *ibid.*).

It is strongly recommended that the data collected in this report be investigated further and in more detail, using the UCINET software (Borgatti, Everett and Freeman, 2002). This would involve a degree of analysis outside the scope of this report; analysing social networks not just in terms of centrality, connectivity, sub-groups and positions (as was begun in this report), but also using stochastic models, measures of similarity and network hypothesis testing with both matrix correlation and multiple matrix regression (Pryke, 2004b). In addition the software contains multivariate techniques such as multidimensional scaling, cluster analysis, correspondence analysis and regression; with data transformation and management tools available include line graphs, converse graphs, node-by-line incidence matrices, multigraphs from valued multiplex graphs, pooled graphs and semi-groups of relations (Borgatti *et al*, 1992:2 cited by Pryke, 2004b).

The effect of culture

The effect of culture upon the social networks analysed in this report cannot be easily disentangled and controlled for. It follows that the findings of this report, based on a single UK-based case study, cannot necessarily be extrapolated neatly to other areas, markets or cultures. For example, Social Networks Analysis of Japanese project coalitions may well produce contrasting results; as the *socialisation* within Japanese firms can produce almost standardised behaviour, where an employee's natural inclination is always to do what is best for the firm (Douma and Schreuder, 2002, p.164). This represents a very different scenario and reward structure from UK models. Consequently, in a different cultural context, the inferences of this report about motivation, power and incentives may not be valid. Similarly, the *Machiguenga* Indians of the Peruvian Amazon strongly deviate from western game theoretic predictions in bargaining games, challenging many widely-held assumptions about incentives and relationships (Heinrich, 2000, cited in Douma and Schreuder, 2002).

So comparison of construction project coalition networks from a range of cultural backgrounds is recommended as a valuable future research route. The approach taken in UK construction projects it's success can be compared and contrasted with other project governance models, for example in the *kanekikai* (Winch, 2002, p.156) and *keiretsu* (Douma and Schreuder, 2002, p. 137) of Japan and the *Guanxi* of China (Douma and Schreuder, 2002, p. 172), the Dutch *Poldermodel* (Winch, 2002, p.92), the French *Milieu*, the rafts of interdependent Italian firms and in the Scandinavian models of vertical integration.

A final comment

The future success of the construction industry has to be realised practically, tested empirically, and analysed academically. This report addressed some of the serious problems besetting the UK construction industry. Our investigations produced a significant amount of high-quality data. The emergent and innovative field of Social Networks provided a suitable theoretical framework for the simultaneous analysis of several key characteristics of project teams, from which powerful conclusions have been drawn and potent recommendations made for both industry practitioners and observers of the built environment.

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[i] In the wake of such monumental events as the World Trade Center attack in September 11th 2001, or the recent bombings in Madrid and London, many organisations have been prompted to examine their social networks and adapt them accordingly. The concentration of resources and information at risk mean that firms may be looking towards distributed structures, based around common tasks (i.e. project coalitions); to be better prepared for disasters; to shorten commutes, and to make efficient use of space (Robbins and Coulter, 2002).

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9.0 Appendices

9.0 Appendices

The following items are enclosed in this section,

i) *Research briefing given to study participants*

ii) *Sample questionnaire and record of case study contractual arrangements*

iii) *Node lists from UCINET 6.0 analysis*

iv) *MSc report summary study programme*

PROCURE 21 RESEARCH

UCL

PROCURE 21

ProCure21 is an NEC-based construction method devised by NHS Estates to meet the future demands of the National Health Service.

The ProCure21 suite of contracts are employed across a programme of healthcare projects; with the aim of fostering collaborative and open project environments which will hopefully result in a high and continuously improving standard of delivery.

Launched in September 2003, ProCure21 is a new and exciting departure for the NHS, it's supply chain and ultimately, the patients. As an emergent form of working, it's success remains to be proven, and research in this area can help to reveal and demonstrate it's merits, risks and possible areas requiring improvement or further development.

Research at The Bartlett School of Postgraduate Studies, University College London, may help us to better understand the value of ProCure 21.

This research uses a technique called Social Network Analysis, which is way of modelling construction projects as a system of firms joined by a variety of relationships, e.g. through contracts, shared risks, design/information flow or financial incentives.

The technique has, in recent years, been used successfully by other sectors in a variety of circumstances, from helping to map and break up Al-Qaeda terrorist cells, to identifying how dolphins form communities and mapping the spread of sexually transmitted diseases in young adults.

It is essentially a way of capturing several different types of relationship simultaneously; the complex mathematical process is neatly summarised by easily interpretable diagrams, which often produce counterintuitive conclusions that 'common sense' or experience alone would not suggest.

In construction, this research method has already been used across a range of building, procurement and contract types (e.g. JCT Traditional and Design & Build, Prime Contracting, PFI) in the UK, France, the USA and China to great effect.

Participation in the research is via a simple tick-box questionnaire.

The published research will be made available to all participants.

For further information, please contact Tom Doyle on 07763 982 353 or t.doyle@bbcl.co.uk

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Confidentiality

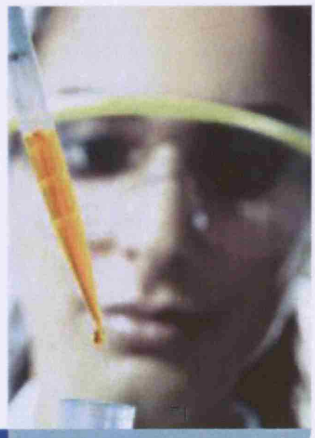
This work is undertaken for research purposes alone, as part of a wider University College London research project.

The project, companies, locations and individuals concerned will remain entirely confidential and will not be named or identified at any point within the report.

As such, participation in this research can be conducted with complete commercial and interpersonal confidentiality.

"We are issuing a challenge to the construction industry to commit itself to change, so that, working together, we can create a modern industry ready to face the new millennium."

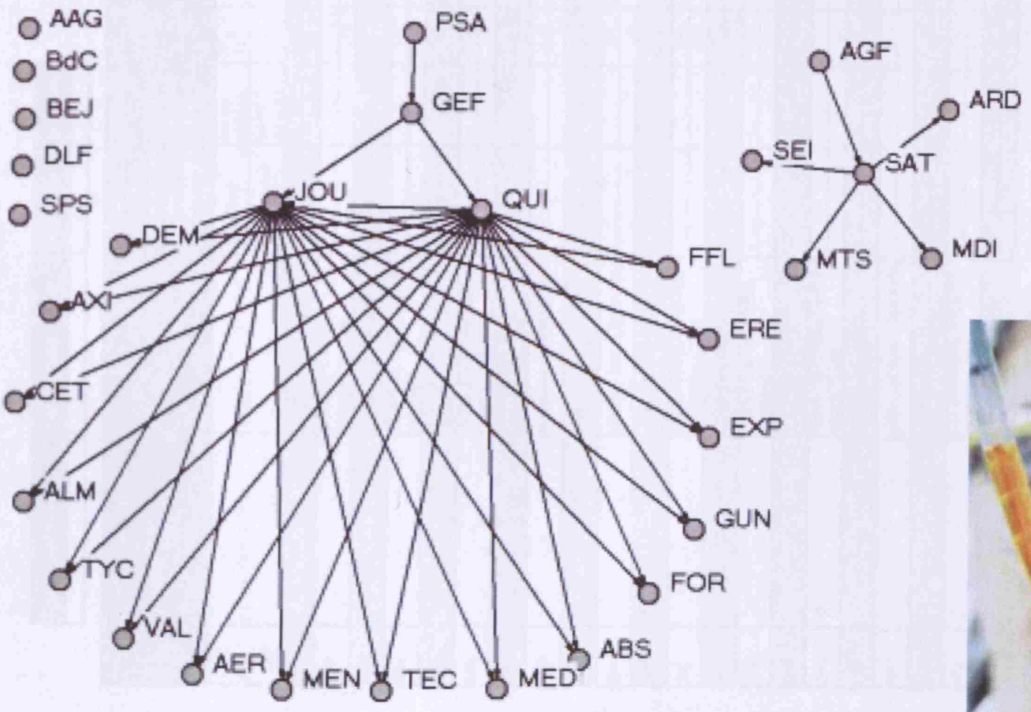
"Rethinking Construction 1998"

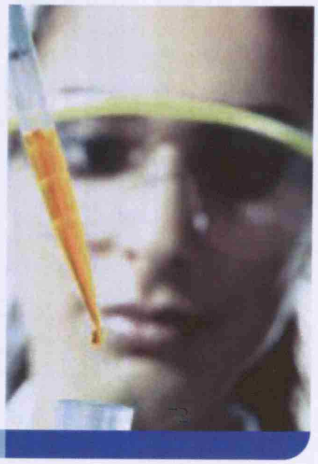


PROCURE 21 RESEARCH

Key to Actor Roles:

AAG	Architect for permit only
ABS	Tiling SubC.
AER	Plumbing SubC.
AGF	Fire insurers
ALM	Lifts SubC.
ARD	Lagging SubC.
AXI	Mechanical services SubC.
BdC	Building Control Office*
BEJ	Design consultancy
CET	Security installation SubC.
DEM	Electrical SubC.
DLF	Project managers to client
ERE	Ironmongery supplier
EXP	Specialist loading ramps SubC.
FFL	Rainwater installation SubC.
FOR	Bricklaying SubC.
GEF	Project managers for construction*
GUN	Steel doors SubC.
JOU	External works SubC.[+main contractor 1of2]
MDI	Specialist SubC.
MEN	Structural steelwork SubC.
MTS	Aerials SubC.
PSA	Client
QUI	Main contractor [2of2]
SAT	Sprinkler SubC.
SEI	Underground services SubC.
SPS	Planning supervisor*
TEC	Internal partitions SubC.
TYC	Fire doors SubC.
VAL	Internal joinery





P21 SNA - Data Collection: Questionnaire Form

Your Company	Today's Date	Your Name	Your Role

Ref.	Company	Activity	People you get information from								People you give information to							
			a: Which people do you get information from?	b: What are their roles ?	c: What is the information about				d: Is this communication ...		e: Which people do you give information to?	f: What are their roles ?	g: What is the information about				h: Is this communication ...	
					Cost	Risk	Prog	Design	Frequent?	Important?			Cost	Risk	Prog	Design	Frequent?	Important?
EXA	EXAMPLAR BUILDING	EXAMPLE	John Smith	Design Manager	Y	Y	Y	Y	Med	High	Rob Wright	General Foreman	N	N	Y	Y	Med	Med
			Hannah White	Quant Surveyor	Y	Y	Y	Y	Low	Med	Simon Jones	Managing Dir.	Y	Y	Y	N	Low	High
AIS		BUILDING REGULATIONS INSPECTOR																
AJM		CONCRETE WORKS SUBCONTRACTOR			Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low			Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low
					Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low			Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low
ARO		PUBLIC ART CONSULTANT																
BAB		PRINCIPAL SUPPLY CHAIN PARTNER			Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low			Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low
					Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low			Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low
BAK		M & E SUPPLY CHAIN MEMBER																
BAN		BRICK & BLOCKWORK SUBCONTRACTOR			Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low			Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low
					Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low			Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low
ENJ		SCAFFOLDING SUBCONTRACTORS																
CAB		PLANNING SUPERVISOR			Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low			Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low
					Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low			Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low
DFR		LABOUR																
ESH		JOINERY UNITS SUPPLIER			Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low			Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low
					Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low			Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low
HAP		CLIENT'S REPRESENTATIVE																
JJC		EARTHWORKS/DRAINAGE SUBCONTRACTOR			Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low			Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low
					Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low			Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low
KON		LIFTS SUBCONTRACTOR																
MEH		CLIENT/END USERS/P21 FUNDING			Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low			Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low
					Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low			Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low
OTP		E.G. PARTY WALL, RIGHTS OF LIGHT ETC.																
OVA		SERVICES CONSULTANT & ACOUSTICIAN			Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low			Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low
					Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low			Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low
PAM		STRUCT CONSULTANT																
PAP		ARCHITECTURAL SERVICES			Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low			Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low
					Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low			Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low
PLW		CURTAIN WALLING																
STA		E.G. PLANNING, ENGLISH HERITAGE ETC.			Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low			Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low
					Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low			Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low
TAT		COST CONSULTANT																
TEM		TEMPORARY ELECTRICS			Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low			Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low
					Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low			Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low
UTI		COMMS/GAS/ELEC/OIL/WATER PROVIDERS ETC.																
	SPARE				Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low			Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low
					Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low			Y/N	Y/N	Y/N	Y/N	High/Med/Low	High/Med/Low
	SPARE																	

P21 SNA - Data Collection: Contractual Arrangements

Ref.	Key Elements of Service Provided	Who pays for the services provided by organisation?	Form of Contract	Basis of Payment	Effects of Good Performance	Effects of Poor Performance
AIS	BUILDING REGULATIONS INSPECTOR	PAP	Paid via Compensation Event	Cost Reimbursible Contract	As per NEC P21 guidance notes	As per NEC P21 guidance notes
AJM	CONCRETE WORKS SUBCONTRACTOR	BAB	NEC Option A	Priced contract with Activity Schedule	As per NEC P21 guidance notes	As per NEC P21 guidance notes
ARO	PUBLIC ART CONSULTANT	BAB	Short Subcontract	NEC Turquoise Book	As per NEC P21 guidance notes	As per NEC P21 guidance notes
BAB	PRINCIPAL SUPPLY CHAIN PARTNER	BAB	NEC Option C	Target Contract with Activity Schedule	As per NEC P21 guidance notes	As per NEC P21 guidance notes
BAK	M & E SUPPLY CHAIN MEMBER	BAB	NEC Option C	Target Contract with Activity Schedule	As per NEC P21 guidance notes	As per NEC P21 guidance notes
BAN	BRICK & BLOCKWORK SUBCONTRACTOR	BAB	NEC Option A	Priced contract with Activity Schedule	As per NEC P21 guidance notes	As per NEC P21 guidance notes
ENJ	SCAFFOLDING SUBCONTRACTORS	BAB	NEC option A	Priced contract with Activity Schedule	As per NEC P21 guidance notes	As per NEC P21 guidance notes
CAB	PLANNING SUPERVISOR	MEH	MEH	Priced contract with Activity Schedule	As per NEC P21 guidance notes	As per NEC P21 guidance notes
DFR	LABOUR	BAB	Short Subcontract	Priced contract with Activity Schedule	As per NEC P21 guidance notes	As per NEC P21 guidance notes
ESH	JOINERY UNITS SUPPLIER	BAB	NEC option A	Priced contract with Activity Schedule	As per NEC P21 guidance notes	As per NEC P21 guidance notes
HAP	CLIENT'S REPRESENTATIVE	MEH	NEC Option E Professional Services Subcontract - Orange Book	Cost Reimbursible Contract	As per NEC P21 guidance notes	As per NEC P21 guidance notes
JJC	EARTHWORKS/DRAINAGE SUBCONTRACTOR	BAB	NEC Option A	Priced contract with Activity Schedule	As per NEC P21 guidance notes	As per NEC P21 guidance notes
KON	LIFTS SUBCONTRACTOR	BAB	NEC Option A	Priced contract with Activity Schedule	As per NEC P21 guidance notes	As per NEC P21 guidance notes
MEH	CLIENT/END USERS/P21 FUNDING	PARTNERSHIPS FOR HEALTH/DoH/INTERNAL	N/A	N/A	As per NEC P21 guidance notes	As per NEC P21 guidance notes
OTP	E.G. PARTY WALL, RIGHTS OF LIGHT ETC.	Various	Various	Various	Various	Various
OVA	SERVICES CONSULTANT & ACOUSTICIAN	BAB	NEC Option E Professional Services Subcontract - Orange Book	Cost Reimbursible Contract	As per NEC P21 guidance notes	As per NEC P21 guidance notes
PAM	STRUCT CONSULTANT	BAB	NEC Option E Professional Services Subcontract - Orange Book	Cost Reimbursible Contract	As per NEC P21 guidance notes	As per NEC P21 guidance notes
PAP	ARCHITECTURAL SERVICES	BAB	NEC Option E Professional Services Subcontract - Orange Book	Cost Reimbursible Contract	As per NEC P21 guidance notes	As per NEC P21 guidance notes
PLW	CURTAIN WALLING	BAB	NEC Option A	Priced contract with Activity Schedule	As per NEC P21 guidance notes	As per NEC P21 guidance notes
STA	E.G. PLANNING, ENGLISH HERITAGE ETC.				As per NEC P21 guidance notes	As per NEC P21 guidance notes
TAT	COST CONSULTANT	BAB	NEC Option E Professional Services Subcontract - Orange Book	Cost Reimbursible Contract	As per NEC P21 guidance notes	As per NEC P21 guidance notes
TEM	TEMPORARY ELECTRICS	BAB	Short Subcontract	NEC Turquoise Book	As per NEC P21 guidance notes	As per NEC P21 guidance notes
UTI	COMMS/GAS/ELEC/OIL/WATER PROVIDERS ETC.				As per NEC P21 guidance notes	As per NEC P21 guidance notes

9.3.1 DoyleCONTRACT

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JJC ARO BAB
BAN ARO BAB
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BAK BAB HAP MEH OVA PAP UTI
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BAB AJM DFR HAP JJC TEM
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9.3.5 DoyleCOMrisk

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9.3.5 DoyleCOMdesign

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```

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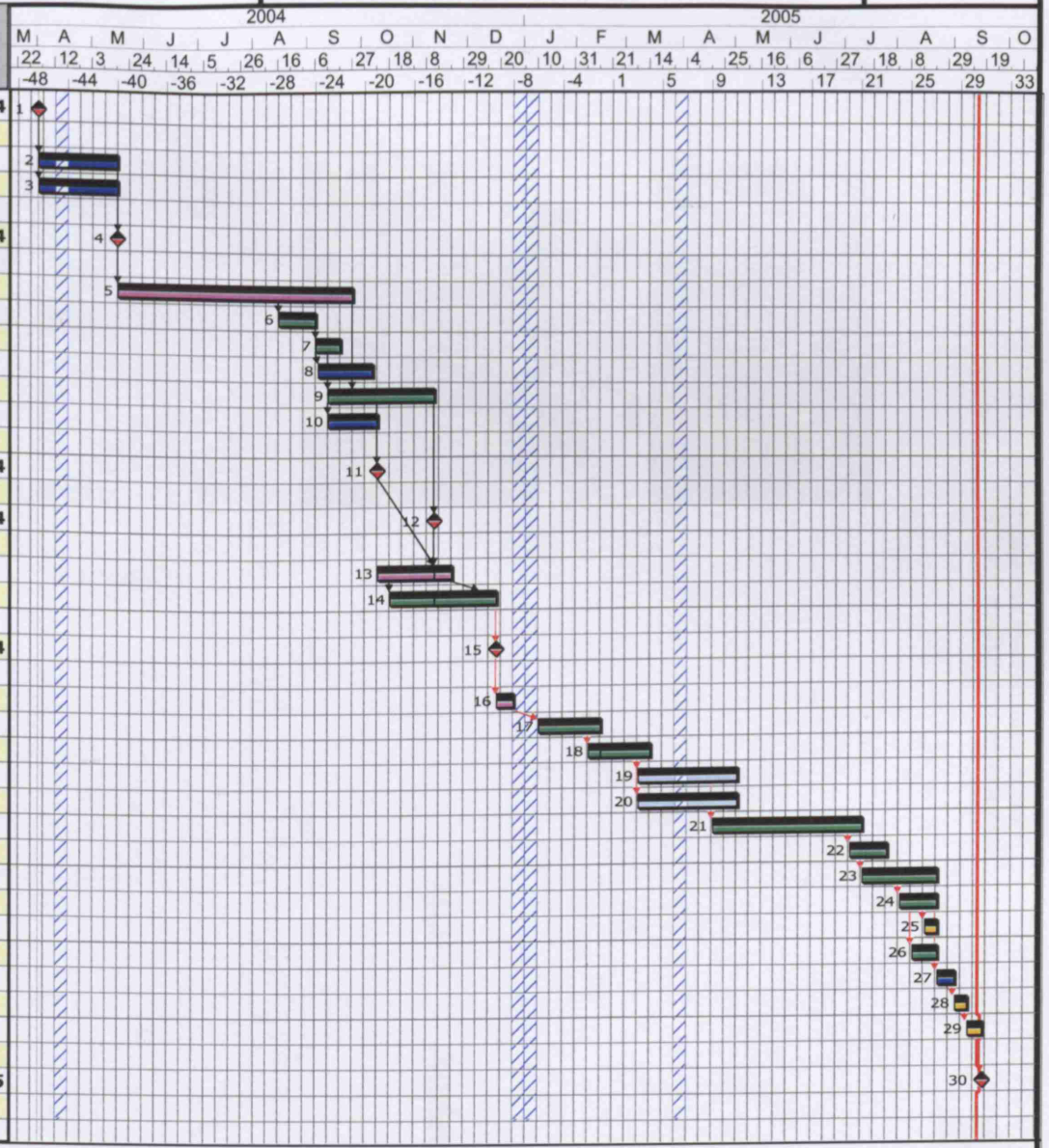
f: +44 (0) 20 7813 2837

Project: **MSc Report: Construction Economics and Management**

Client: **The Bartlett School of Graduate Studies**

MSc Report: Summary Research Programme

Line	Task name	Start	End
1	**COMMENCE REPORT WORK**	**01/04/2004**	**01/04/2004**
2	DEVELOP INITIAL KEY IDEAS	01/04/2004	14/05/2004
3	READINGS FOR INITIAL TOPICS	01/04/2004	14/05/2004
4	**SUBMIT INITIAL IDEAS FOR REVIEW**	**17/05/2004**	**17/05/2004**
5	FEEDBACK PERIOD	17/05/2004	24/09/2004
6	REFINE IDEAS AND KEY TOPICS	16/08/2004	03/09/2004
7	SELECT GENERAL REPORT TOPIC	06/09/2004	17/09/2004
8	READ KEY PROJECT THEORY TEXTS	07/09/2004	06/10/2004
9	DEVELOP DRAFT OUTLINE AND PRESENTATION MATERIAL	13/09/2004	10/11/2004
10	READ PREVIOUS MSc REPORTS	13/09/2004	08/10/2004
11	**SUBMIT DRAFT OUTLINE FOR REVIEW**	**11/10/2004**	**11/10/2004**
12	**REPORT OUTLINE PRESENTATION**	**11/11/2004**	**11/11/2004**
13	FEEDBACK ON OUTLINE AND PRESENTATION	11/10/2004	19/11/2004
14	INCORPORATE FEEDBACK INTO REPORT OUTLINE	18/10/2004	15/12/2004
15	**SUBMIT FINALISED REPORT OUTLINE**	**16/12/2004**	**16/12/2004**
16	RECEIVE FORMAL FEEDBACK ON FINALISED REPORT OUTLINE	16/12/2004	24/12/2004
17	STATEMENT OF THE PROBLEM	10/01/2005	11/02/2005
18	RESEARCH DESIGN	07/02/2005	11/03/2005
19	DATA COLLECTION - STRUCTURED INTERVIEWS	07/03/2005	29/04/2005
20	DATA COLLECTION - QUESTIONNAIRES	07/03/2005	29/04/2005
21	ANALYSIS OF DATA	18/04/2005	08/07/2005
22	REVIEW RESEARCH LIMITATIONS AND ASSUMPTIONS	04/07/2005	22/07/2005
23	CONCLUSIONS	11/07/2005	19/08/2005
24	RECOMMENDATIONS	01/08/2005	19/08/2005
25	COLLATE APPENDICES	15/08/2005	19/08/2005
26	COMPLETE REPORT BIBLIOGRAPHY/REFERENCES AND REVIEW	08/08/2005	19/08/2005
27	FINAL REVIEW PERIOD	22/08/2005	30/08/2005
28	ADDENDA AS NECESSARY	31/08/2005	06/09/2005
29	CREATING HARD COPY AND ELECTRONIC DOCUMENTS	07/09/2005	14/09/2005
30	**COMPLETION OF MSc REPORT**	**14/09/2005**	**14/09/2005**



Summary

Review by Tutors/Peers/Colleagues | Working with report data | Writing | Admin/Other | Reading | Key Dates

Prep by: Tom Doyle	Checked by:Graham Ive/Hedley Smyth/Stephen Pyrgo (Bartlett Grad School)	Revision Comment: Revised for Report Outline Presentation	Rev Date: 14/05/2005	Rev No: B	Prog No: MSc/TD-01

Project Ref. C:\Documents and Settings\tomd\My Documents\Msc Work, ICE, Be, CSCS\MSc Report\Study Programme\First Stage Programme Rev C- September 2005.pp

10.0 Addenda

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Addenda, if required, will be appended overleaf.

Note: At the date of submission (September 2005) there are no addenda.